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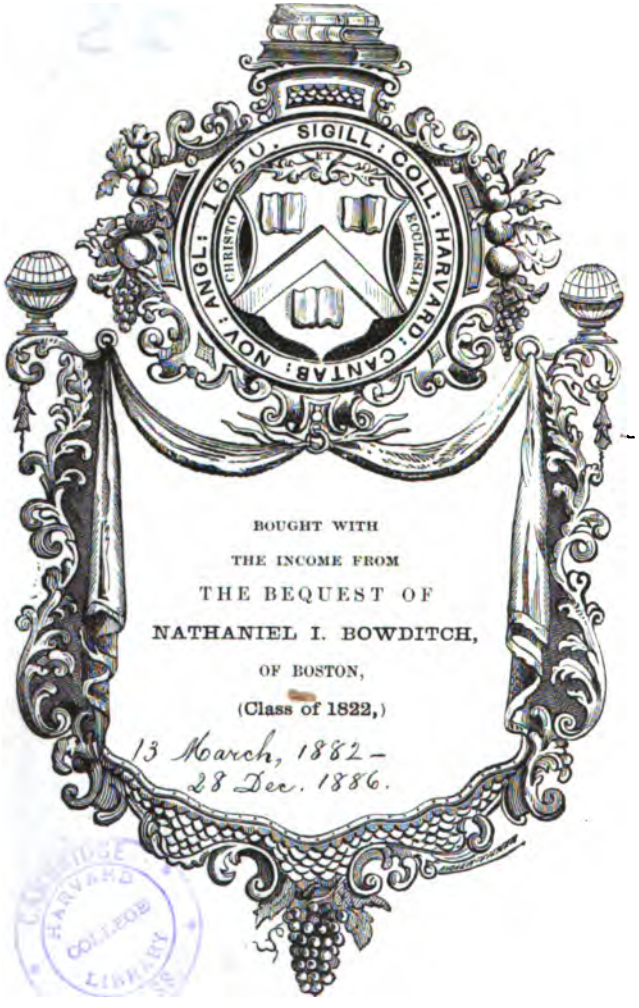

THE

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MICROGRAPHIC DICTIONARY.

THE

MICROGRAPHIC DICTIONARY;

A GUIDE TO THE EXAMINATION AND INVESTIGATION

OF THE

STRUCTURE AND NATURE

OF

MICROSCOPIC OBJECTS.

BY

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FOURTH EDITION.

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ILLUSTRATED BY FIFTY-THREE PLATES AND EIGHT HUNDRED AND EIGHTEEN WOODCUTS CONTAINING FIGURES OF 2680 OBJECTS.

VOL. I.—TEXT.

LONDON:

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PREFACE.

ON arriving at the conclusion of their labours, the Authors feel that some apology is, in the first place, due to the Subscribers, for the extent to which the number of these pages has been increased beyond the original estimate. They have, however, the pleasure of stating that no complaints have been addressed to them on this head; but, on the contrary, strong injunctions, when the work was somewhat advanced, to allow no considerations of arbitrary limits to prevent equal justice being done to the subjects falling under the later letters of the alphabet. They feel therefore that due allowance has been made for the difficulty of calculating beforehand the extent of a work like the present, and that the circumstance which has chiefly led to the enlargement of the volume, namely the revision of the articles at the latest moment before committing them to press, has been duly taken into account.

Secondly, a few observations may be offered on the character, objects, and uses of the work. It was stated in the Prospectus, that the 'Micrographic Dictionary' was offered as an index to our knowledge of the structure and properties of bodies revealed by the Microscope. The Authors venture to hope that their work may possess many useful qualities beyond those strictly implied in the above definition.

Few or none of the works hitherto published have dwelt upon the manner in which observers might judge of the structure of objects from the appearances presented under the Microscope. There are works treating of the construction of the mechanical and optical parts of the instrument, and the manner of using them, of the methods of preparing objects for examination; and to these are usually appended lists of objects presenting interesting appearances. But there exists no work which will direct the Student how to vary the methods of preparation of the objects examined, so as to elicit their true structure.

An Introduction has been prefixed to the 'Dictionary,' affording instruction for the selection of a Microscope and the accessory apparatus, explaining the manner of using these, and particularly the precautions requisite with the less perfect but more economical foreign glasses; and, lastly, entering minutely into what may be called microscopical manipulation and the special education of the eye.

Many valuable contributions to our knowledge of the structure or functions of microscopic organisms are probably lost through the inability of microscopic observers to ascertain readily the name and position in Nature of objects which fall under their notice. It is hoped that the very

numerous illustrations to this work will form a valuable guide in such cases, and render the descriptions of microscopic animals and plants, of minute structures, tissues, &c., which form the main body of the volume, a real dictionary of objects. At the same time it is not unreasonable to expect that much advantage may be derived from the attention that has been paid to directing observers to subjects and disputed points on which new information is desirable.

To the lovers of Comparative Anatomy, Physiology, or of the Natural History of the microscopic members of the Animal and Vegetable Kingdoms, the Authors have endeavoured to furnish, without departing from the principal purpose of the work, something more than a mere descriptive catalogue of objects, and the means of examining them. Numerous articles on various subjects have been written with a view to enable readers, by the help of the system adopted, and references printed in SMALL CAPITALS, to acquire a general knowledge of particular departments of science. Thus, taking a departure from the article ANIMAL KINGDOM or VEGETABLE KINGDOM, the reader may proceed to the *Classes* and *Orders* there enumerated; under the latter will be found a general description of these (where the microscope is much required in their investigation), followed by a reference to the *Genera*, under which is given more or less extensive information on the *Species*, according to the state of knowledge, or as the subject has seemed to require. Proceeding from the article TISSUES, in like manner, the details may be gradually collected by tracing them through the subdivisions by means of the references. Many other general articles are given, with such headings as the names of well-known organs or substances, of vital or other phenomena, &c., under which could be conveniently collected references to a variety of miscellaneous information scattered through the alphabetical arrangement. Those who use the volume in this way will probably derive the greatest amount of advantage from it; they will, it is true, most clearly perceive the deficiencies inevitable in a great measure to a work having such an extensive field, and at the same time so limited a compass.

The results of a large amount of independent observation have been consigned to these pages; and, as the bibliographical references show, recourse has been had, as far as possible, to original sources for trustworthy and reliable information published at home and abroad. In connexion with this, some account may be given of the illustrations. In the Plates, a large number of the figures are original, drawn from the objects either by the authors or by Mr. Tuffen West; in many cases, however, figures of species have been designedly taken from original plates, especially when the verbal characters were doubtful. The Authors feel bound to express their thanks to Mr. West for the manner in which he has applied his well-known skill and accuracy to those engravings which were entrusted to him: many of them, indeed, appear at first sight somewhat crowded and on a small scale; but they will be found in most cases to display very clearly the parts of objects on which *systematic* or *structural characters* depend, the chief design of all the illustrations of this work. With regard

to the engravings in the text, a portion have been selected, after comparison with the objects themselves, from the excellent illustrations of the *Mikroskopische Anatomie* of Kölliker. Most of the woodcuts of plants are careful reproductions of drawings contained in original works and memoirs by Kützing, Corda, Tulasne, Bischoff, Bruch and Schimper, and others, prepared for Payer's *Botanique Cryptogamique*, to which, as to almost every illustration in this volume, the *magnifying power* used has been added. Had not these beautiful woodcuts been accessible to the publisher, it would have been impossible to have provided this work so richly with illustrations.

The authors have much pleasure in acknowledging their obligations to the Rev. M. J. Berkeley, Messrs. Westwood, W. S. Dallas, Sollitt, and Tuffen West, for the loan of authentic specimens, or for information kindly afforded on various subjects, and to Dr. William Francis, for constant advice and assistance during the printing of the work.

JOHN WILLIAM GRIFFITH.
ARTHUR HENFREY.

London, December 1855.

PREFACE TO THE SECOND EDITION.

I REGRET that the task of writing the Preface to this Second Edition of the 'Micrographic Dictionary' falls upon me alone, the hand of Death having just been laid upon my distinguished and most amiable friend and coadjutor. It will, however, be satisfactory to the reader to know that the whole had passed under the hands of the late lamented Professor Henfrey, and that he had taken his share in correcting for the press all but the last three sheets.

The work has been revised throughout, and has received considerable alterations and additions. The progress of Structural and Physiological Botany was always assiduously watched by Professor Henfrey; and the articles on Botanical subjects have been greatly enriched by the additions which his extensive and accurate knowledge suggested to him. Great improvements have also been introduced into many of the articles relating to the Animal Kingdom, especially in the classes Insecta, Tunicata, Polyzoa, and Foraminifera, some members of which have lately attracted much attention. The new figures added are also numerous.

The critical reader will, it is hoped, consider that the great range of subjects embraced, renders it impossible to do justice to all of them; and in

many cases we have been compelled to limit our notices to little more than the characters by which the objects are distinguishable in their respective classes, &c. This has always been a great point in the composition of the work—to enable the microscopic observer to discover what any object is which may be presented to him, and by the aid of the Bibliography to refer to more extended treatises for further details.

Our thanks are again due to those who have kindly lent us aid, especially to Mr. Dallas for the articles Aphidæ, Chalcididæ, and Cynipidæ; and also to those who supported us by their friendly notices of our former labours.

J. W. G.

December 6, 1859.

PREFACE TO THE THIRD EDITION.

AT last the third Edition of the 'Micrographic Dictionary' is completed. But I feel that some explanation, or even apology, to the Subscribers is requisite, considering the delay that has occurred in its issue. To ill-health and press of professional engagements this is attributable. For some time, being constantly in the hope of rapidly completing the work, I hesitated to place it in other hands, until at last I found it essential to do so. The editing of the work subsequently to the letter H was therefore transferred to Prof. Duncan, whose name will form a sufficient guarantee that it has been satisfactorily accomplished.

In regard to the alterations made in this Third Edition, it will be noted that nearly 100 pages of new matter have been added. The original articles have been revised according to modern researches and views, so as to represent, as far as space would permit, the present state of knowledge.

When I state that the Articles upon the Fungi were intrusted to the Rev. M. J. Berkeley, and those upon the Foraminifera to Prof. Rupert Jones, the reader will surely feel confident that they have been carefully and faithfully elaborated. For some valuable notes on the Lichens I have to thank the Rev. W. A. Leighton.

An important novelty in this Edition consists in the accentuation of the names forming the headings of the articles. The classical pen of the Rev. M. J. Berkeley has afforded aid upon this point also.

The Plates have all been newly engraved upon copper, thus rendering the figures of the objects more sharply defined. Three new plates have been added, and several of the original Plates have been re-arranged and improved.

J. W. G.

December 2, 1874.

ERRATA.

Page 51, col. 1, line 5 from bottom, *for* Pl. 23 *read* Pl. 30.
56, col. 1, line 14 from bottom, *for* Plans *read* Plants.
60, col. 2, line 11 from bottom, *for* Pl. 2 *read* Pl. 6.
68, col. 2, line 21 from top, *for* labrum *read* labium.
87, col. 1, line 15 from bottom, *for* Cyclostomata *read* Ctenostomata.
91, col. 1, line 16 from bottom, for *rhitidome* read *rhytidome*.
103, col. 2, line 6 from bottom, *for* muscular *read* molecular.
112, col. 1, line 25 from top, *for* inorganic *read* organic.
168, col. 2, line 25 from bottom, *for* structurs *read* structures.
221, col. 2, line 11 from top, for *spirillium* and *spirillia* read *spirillum* and *spirilla*.
231, col. 2, line 9 from bottom, for *Cestoiden* read *Cestoides*.
261, col. 2, line 10 from top, for DIDIMIUM *read* DIDINIUM.
318, col. 1, line 27 from top, *for* introcellular *read* intracellular.
495, col. 1, line 29 from top, *for* $\frac{1}{1\,5\,0\,0}$ *read* $\frac{1}{1\,5\,0\,0}$.
525, col. 1, line 8 from bottom, *for* always *read* also.
577, col. 2, line 16 from bottom, *for* PARAPHY'SES *read* PARAPH'YSES.
621, col. 1, line 12 from bottom, *for* Actinaria *read* Actinozoa.
661, col. 2, line 20 from top, *for* pearlite *read* perlite.
664, col. 1, lines 22, 25, and 26 from bottom, *for* Noscau *read* Nosean.
675, col. 1, line 5 from bottom, for *Symbistes* read *Symbiotes*.
682, col. 1, line 12 from top, for *Spirillum* read *Vibrio*; and *for* inflexible *read* flexible.

PREFACE TO THE FOURTH EDITION.

IN regard to the completion of the Fourth Edition of the 'Micrographic Dictionary,' few remarks seem necessary. It may be stated, that the work has been thoroughly revised. The systematic portions of the Animal and Vegetable Kingdoms have been re-arranged according to modern views, as far as is consistent with reference to existing standard treatises and monographs of the individual subjects. The structural portions have also been enlarged and corrected in relation to recent observations and experiments. The very large number of new genera, founded especially by Kent, Brady, and Buckton, have been noticed, but in many cases somewhat briefly, especially when the objects are rare or not likely to be easily accessible. Had this not been done, the work would have been extended beyond the proposed limits; the references to the original descriptions have, however, always been appended. Five new plates and some new woodcuts have been added; and the former plates have been altered and corrected where found necessary. The older nomenclature of the chemical substances is retained, according to which these are usually known and purchased. We have to thank Mr. Rutley for his excellent plate and article on Rocks; and Mr. Harkness, of the Government Excise department, for his plate of Adulterations. The articles on the Fungi and the Foraminifera have again been revised by the Rev. M. J. Berkeley and Professor Rupert Jones. Our thanks must also be given to Mr. McLachlan and the Rev. Mr. Leighton for some friendly and valuable remarks. Nor must we fail to acknowledge the assistance afforded by our publisher, in the loan of some of his expensive works; and the aid derived from the use of the magnificent Library of the Royal College of Surgeons, with the courtesy of the Librarian, Mr. Chatto. We hope and trust that this Edition will be found as useful and interesting as the three previous ones have surely been.

J. W. G.

December 26th, 1882.

INTRODUCTION.

I.—USE OF THE MICROSCOPE AND EXAMINATION OF MICROSCOPIC OBJECTS.

Before entering upon the special consideration of the Microscope, of which the Introduction treats, it may be well to make a few remarks upon the general use of the instrument in the examination of minute objects.

The Microscope will either be used as a means of affording amusement, or with a view to scientific research. In the former light, no philosophical instrument can compete with it, in regard to the great variety, the beauty, and the wonderful phenomena of structure which the minute objects it enables us to examine display, even independently of the consideration of the functions and uses of their several parts. In this light also, the investigation of the comparative structures and properties of various bodies or substances used in daily life as articles of food, dress, &c. will form subjects of intense interest to any one who may be possessed of the instrument. The mysterious phenomena of growth, reproduction, and crystallization may also be watched throughout their progress, just as we can see the effects of parts of machinery with the naked eye. But while the sense of sight is thus gratified, the mind will not be unoccupied; for every fresh appearance will impress a new fact; so that here we have both amusement and instruction combined.

It is, however, to the use of the Microscope as a means of scientific research that our remarks are most necessary; for in this great care and consideration are required, and these are very apt to be neglected by those who are unaccustomed to employ this valuable instrument.

The Microscope as a means of investigation might perhaps be thus defined: the microscope is an optical instrument constructed in order to enable us to investigate the characters and properties of those objects which we are unable to study with the unassisted eye, on account of their minute size.

The use of the Microscope will resolve itself into either that of proving the structure of a known object, or determining that of a new one; and in thus applying it, exactly the same precautions must be adopted, and just the same course pursued, as if the object under

examination were distinctly visible to the unaided eye. The above formal definition of the true use of this valuable instrument is requisite, because it is very frequently used simply as a means of *viewing* minute objects, and judging of their nature from the mere inspection of them under the conditions in which they naturally or accidentally occur. Such a procedure, the most casual observer must be well aware, is never trusted alone in the examination of objects visible to the naked eye, being almost sure to lead to erroneous conclusions. Consider the common course pursued in the macroscopical examination, or that with the unaided sight, of a body for the first time presented to our notice! The first point is the examination of its general appearance and colour; the relative position of the eye of the observer and the object is then changed, so that an idea of its solidity may be obtained; its weight is next perhaps determined by taking it in the hand; it is presented to the light in various ways, in order to judge of its transparency, and of the optical properties of its surface. If the object be at a distance, its size is judged of by comparing its apparent size with that of adjacent bodies, whose dimensions are approximately known; and its luminousness is also taken into consideration, it being known generally that the nearer bodies of the same size are to us, the more luminous they appear. The observer then is either satisfied with the conclusions drawn from reasoning upon the results thus obtained, or he makes besides a chemical examination.

Again, care should be taken to avoid forming an opinion upon the normal or abnormal state of an organic structure, without a previous knowledge of the natural structure of organic tissues. We therefore recommend the student, before he thinks of recording his observations, to begin by testing the structure of any objects which may come in his way, or that of the TEST-OBJECTS which we have described, according to the rules laid down in the second part of this Introduction.

It may be remarked for those who have but small means at their command, and who are unable to procure a first-rate English microscope, that perhaps very many of the facts elicited by the use of this instrument have been determined by our continental neighbours with far less perfect instruments, who have made up for the imperfections of their instruments by extreme patience, care, and repeated observation; which can be done to an extent that would scarcely have been anticipated.

We have alluded to these sources of error merely for the purpose of warning future observers, and impressing upon them the importance of making themselves acquainted with the difficulties attendant upon microscopic investigations, and with the best means of overcoming them. In fact, it may be briefly stated that the object of the present work is to guide the microscopist in his researches, to give him a notion of the manner of making these researches, also some account of the characters, microscopic structure, and properties of objects in general, and to show how he may most easily arrive at satisfactory results.

But there are difficulties inherently connected with the examination of microscopic objects, which are not encountered when objects are examined with the naked eye. One of these is that, with the ordinary microscope objects are only viewed with one eye; hence we lose the direct power of distinguishing solidity, &c., and are compelled to resort to indirect means for these purposes. This difficulty is to some extent overcome by the construction of binocular microscopes. Again, the ordinary objects around us are also usually viewed by reflected light, whilst with the microscope they are mostly viewed by transmitted light, and we are consequently much less practised in judging from the appearances of objects thus illuminated, and are therefore liable to err.

Another, but a less important difficulty in microscopic investigations, or at least manipulations, consists in the image of the objects being inverted. Erecting eyepieces, as they are called, will obviate this difficulty; but as they are expensive, and interfere with the distinctness of the images of the objects, and as the difficulty is to a great extent got over by practice, they are rarely used.

Another very serious source of error lies in the tendency to reason from analogy as to the structure or nature of a body viewed under the microscope. Any one who pursues this course has his mind prejudiced by preconceived notions, and becomes in fact no observer at all.

It need, moreover, be merely remarked that the ordinary appearance of objects to the naked eye depends in all cases upon a molecular structure, which is generally microscopic, the ordinary appearance being the optical result or expression of this structure; and since totally dissimilar microscopic structures may present similar appearances to the unaided eye, judgment as to the nature of the former founded upon the latter can be of but little value. The reader will remember that the common capability of distinguishing objects or structures by their appearance has been derived, so to speak, from practice and experience of effects; and when we bear in mind that the experience and practice in the study of the causes are attainable, the superiority of the latter must be evident.

Next to the improvement effected in the optical construction of the microscope during the last few years, must be placed that of the method of investigation. Formerly almost all microscopic bodies possessing different forms and appearances were considered distinct beings, and were named accordingly. By the present method, prolonged observation is adopted to follow the changes which the individual bodies undergo; whence it has resulted that numbers of them have been found to be simply different stages of each other. Thus a large amount of useless nomenclature and confusion is being removed from the domain of the microscopic world.

Above all, however, it must never be forgotten that microscopic investigations require more time and patience than perhaps any others, even in regard to the determination of simple points of structure and qualitative composition. In fact, notwithstanding the innumerable observations made upon the more minute objects, such as the scales of insects, the markings on the valves of the Diatomaceæ, the fibrillæ of muscular fibre, &c., such differences of opinion are still entertained, that it can by no means be asserted that the structure of these bodies is positively known.

The time has passed at which the value of microscopic research could be called in question. The wonderful insight gained by its use into the structure and functions of the various organic beings belonging to the Animal and Vegetable Kingdoms, the aid it has afforded Geology, the so-called practical applications it has permitted in improving the arts, in detecting adulterations, and in defeating crime, moreover the almost positive certainty we have obtained that it is capable of displaying all the real structure which bodies possess, save that of their ultimate molecularity, which will probably always be hidden from us, are sufficient to deprive this question of any interest.

Lastly, if it were required to prove design in the creation, this could not be more easily effected than by the examination of the structure of microscopic organisms.

We have expressed our intention of not entering upon a description of the microscope as an optical instrument, because it would have been requisite to tread widely the field of general optics, which our space does not permit. We would therefore advise those who

wish to become acquainted with the microscope as an optical instrument, first to study the general laws of optics, which may be done through the medium of any of the works or treatises on Natural Philosophy—as the article 'Optics' by Herschel in the Encycl. Metropolitana, Brewster's 'Optics,' Lloyd's 'Manual,' Deschanel's 'Optique,' Verdet's 'Leçons d'Optique Physique,' Nägeli and Schwendener's 'Mikroskop,' 'Ganot's 'Physique' (transl. by Atkinson), or Rodwell's 'Dictionary of Science.' Perhaps the second work is the best for the general reader; it is an old standard work, but greatly behindhand in regard to the use of the microscope. They may then proceed to the application of these laws to the various optical parts of the microscope. This will be found in the works enumerated at the end of the Introduction.

We must not, however, omit a notice of the principles which should guide in the selection of a microscope and the accessory apparatus, because a large number of microscopes are at the present day sold, frequently at no mean cost, which, although well calculated to afford amusement, are utterly valueless for the purpose of scientific investigation. To those to whom money is no consideration, we may recommend with safety, as the best which can possibly be procured, such as are manufactured by Ross, Smith and Beck, or Powell, of London. These makers have a thorough knowledge of the instrument, and a reputation at stake; hence there is little occasion to test their instruments. But it may happen that a person may not wish to expend so much money as the purchase of these instruments requires, may wish to procure a foreign instrument (and these are cheaper), or may meet with one second-hand. A word or two may then be of service in guiding them in their choice; for a microscope may look very well and very handsome, yet be worth but little. It must, however, be borne in mind that there is much room for opinion in these matters; for according to what any one has been accustomed to, or according to prejudice arising from what he may have heard a supposed authority say, so will an instrument or a piece of apparatus be regarded as requisite or of importance, or not. Our statements rest upon our own experience in the long-continued use of the instrument, and as such they must be taken.

First, it may be remarked that the microscope is usually regarded as composed of the stand, body, stage, eye-pieces, and object-glasses: and the object-glasses are generally sold separately; for by means of an "adapter" they can be applied to any microscope.

In regard then to the stand, body, &c.: the *stand* should be firm, and so heavy and its feet so arranged, that the instrument cannot be easily overturned.

The *body*, whether the microscope has one body only, or is binocular, should be about 8 or 10 inches in length; in many of the foreign and cheap English instruments the body is short, and the eyepieces are adapted accordingly; but this adaptation is decidedly objectionable.

Whether the microscope shall be binocular or not must be a matter of opinion. In the binocular microscopes there are two bodies and two eye-pieces, the rays of light just above the object-glass being divided by a refracting prism into two portions, one of which passes through each tube; in this way the stereoscopic view of objects is obtained. The binocular arrangement is an additional expense; it can be added to any microscope; but any binocular microscope can be used as a single-bodied instrument (See BINOCULAR).

The microscope should be so constructed that the body can be inclined at any angle desired, so that the observer may examine objects while sitting. Many persons, however, prefer to use the microscope with the body placed perpendicularly; and when chemical

reagents are to be applied this position is essential; but when long-continued examination of an object is required, it becomes very painful and fatiguing to keep the head in the position which the perpendicular position of the body requires. Moreover, as in a microscope with the joint or arrangement by which the body can be inclined the body can always be placed perpendicularly, the joint is decidedly advantageous. Again, it is almost essential when the camera lucida is used. A brass pin or some similar contrivance should be placed near the joint so as to check the motion of the body of the microscope when it reaches the horizontal position; no microscope should be without this.

In most microscopes a tube sliding within the body and carrying the eyepiece forms a "draw-tube." By drawing this out the magnifying power becomes enlarged without changing the eyepiece; it is very useful with the erector or erecting-glass (p. xxii); and serves occasionally to produce slight corrections for variations in the thickness of the covers, with immersion-lenses.

The microscope should have a coarse *rack-and-pinion* movement or *quick motion* for adjusting the focus of the lower powers or object-glasses; and when used with an object-glass of about half an inch focus, the image of the object examined whilst coming in and going out of focus, must not appear to move from one side to the other of the field when the body is raised or depressed by the coarse movement. Also when the milled head of the coarse movement is rotated, the motion should feel smooth, not irregular, uneven, or jerking. In some foreign microscopes, the effect of the coarse rack-and-pinion movement is replaced by the sliding of one tube within the other, the body consisting of two tubes working after the manner of those of a telescope. This arrangement is very objectionable, although used by some very good observers, who probably have more tact than most people, and who do not use such high powers as they ought; for when the highest powers are used it is perfectly intolerable. The objection is somewhat overcome in some microscopes by the existence of a fine movement; but we regard the rack-and-pinion coarse adjustment as essential.

A *fine movement* or *slow motion* is indispensable; for with the higher powers (one eighth and upwards) it is impossible to adjust the focus without it. When the finger or fingers are applied to this in its use, no apparent motion of the object must take place; should this occur, the movement is worthless, unless, at all events, it is very slight, and this when tested with the high powers.

When the milled head of the fine movement is turned backward and forward, as in use, the motion should be perfectly even, and should be produced very easily, with slight pressure only of the finger or fingers; moreover no difference should be distinguishable between the two directions in which it is turned, but it should move with equal ease in both.

The *field* or luminous disk on which the objects viewed through the microscope are apparently delineated, should have its marginal line clear and black. If this line appear coloured, the eyepiece is not as it should be.

The *stage* should not be too small, (say less than 3 inches in diameter). To the best instruments a moveable stage is adapted; but whether this is essential or not is considered a matter of opinion. Undoubtedly with low powers the moveable stage may be dispensed with, and is not often used; but with the higher powers its absence is felt greatly, and we should say that it is essentially necessary. In most of the English microscopes, whether provided with a moveable stage or not, there is a "sliding piece" for producing the back-

ward and forward motion of an object, the lateral motion being effected by direct application of the fingers. If the body of the microscope is to be used in the inclined position the sliding piece or a moveable stage becomes essential.

If the moveable stage be present, the "milled heads" should be pretty large, so as to be readily grasped, and a flat object should remain in focus whilst traversing the field by the movement of the stage. The stage should also be very thin.

The *mirror* should have one plane or flat face, and another concave. It should not be too small; and its centre should coincide with the axis of the body of the microscope. A double arm enables the mirror to be brought more considerably to either side, so as to throw more oblique light upon an object.

So long as the above conditions are fulfilled, the general form and arrangement of the stand and its parts are of little consequence. It must also be remembered that the complication and accuracy of the apparatus required will vary according to the kind of investigations pursued. Thus the structure of the various tissues of animals, and that of most plants, can be satisfactorily studied with apparatus which is totally insufficient to display the structure of certain of the more minute and difficult objects; but, on the other hand, it follows that if a peculiar structure can be shown to exist in any kind of objects by a complicated apparatus, which cannot be demonstrated by a more simple or less perfect apparatus, the study of the structure of any object not previously examined must always be attended with uncertainty so long as it has not been tested by the more perfect kind of apparatus,—provided the microscopist has not acquired the art of replacing the imperfection of his apparatus by superior tact and management, which can be done to a great extent.

Object-glasses, often called *Objectives*.—These form the most important portions of the microscope. The value of the object-glasses depends mainly upon their freedom from chromatic and spherical aberration, and upon the magnitude of their angular aperture. The freedom from the former renders them good in defining power, *i. e.* in exhibiting clearly the margins or outlines of objects or structures; whilst large angular aperture renders them capable of penetration, or of resolving the more delicate markings upon the surface of objects. But there are two kinds of penetrating power, as we shall show in the article "TEST-OBJECTS," where we have entered more fully upon this subject.

As in the case of the stand &c. of microscopes, so in regard to the object-glasses; the best are made in this country, and can be obtained of first-rate quality of the three makers above-mentioned. But the French and German object-glasses have been very greatly improved in late years, and are now largely used, especially the immersion-glasses as they are called (OBJECT-GLASSES); and some of these resolve perfectly most of the difficult valves of the Diatomaceæ; and they are cheaper than the English glasses. The names of Hartnack, Zeiss, and Gundlach are well known as those of excellent makers. Some of the American object-glasses also, which are but little known in this country, must stand in the first rank in regard to excellence in defining and especially penetrating power. When a glass of unknown value, however, presents itself, it should be tried upon the test-objects.

The defining power may be tested by the examination of the objects figured in Plate 1. figs. 1 to 4.

The outlines or margins of these objects must appear black, well defined, and perfectly free from colour, not misty, nor red or green; they should retain this appearance when the higher eyepieces are used, of course some allowance being made in regard to the sharpness of outline, which will appear slightly broader and less defined, but nowise interfering

with the distinctness of the image of the object. The various parts of an object lying in the same plane, as a transverse section of whalebone, should also be visible at the same focus; the lines upon a micrometer used as a slide will also serve to test this point. It is not, however, of very great importance, especially with high powers; but it is a character of a superior object-glass.

If the definition of the glass be good, the field flat, and the power adequately high, it will also exhibit the structure of the objects in Plate 1. figs. 5, 6, 10, 12, and 13 clearly and distinctly; it is then of sufficiently good quality for nearly all the purposes required in the investigation of animal and vegetable structures.

The exhibition of the objects illustrated by Plate 1. figs. 6, 7, 8, 9, 10, 11, 12, and 13 requires the first kind of penetrating power, but it does not require large angular aperture. The second kind of penetration, however, requires, above all, large angular aperture, independently of any other superiority; *i. e.* a glass may be perfectly corrected as to defining power, and exhibit the above objects well, yet when the valve of a *Pleurosigma* is subjected to it the markings cannot be distinguished without particular appliances, which produce the same effect as an increase of angular aperture in the object-glass. As this property is therefore principally dependent upon the angular aperture, this should be determined by direct measurement; the method of doing which is described under the article "ANGULAR APERTURE," in which also is contained a list of the various apertures of the best glasses, so that the approximation in the case of any glass to these magnitudes will afford an indication of its quality. It must be observed that increase of angular aperture in an object-glass involves an increase in price.

The following remarks may perhaps assist in guiding the judgment in regard to the selection of an object-glass:—

Large angular aperture is of less importance in the case of a low than of a high power.

Large angular aperture is neither requisite nor advantageous in physiological and medical investigations in general.

Whether a glass of larger aperture will exhibit any further structure than one of less aperture has already done, can nearly always be predicted from other means.

Object-glasses of high power and large angular aperture require to be brought very close to the objects viewed, which is a great disadvantage, rendering them useless for general investigations.

In regard to objects requiring large angular aperture for exhibiting their structure, much depends upon the management of the light; so that a glass may fail in exhibiting certain parts of structure in the hands of one of but little experience, whilst in the hands of another it may show them distinctly. Hence the direct measurement of the angle is best, to determine what a glass is capable of exhibiting when properly used.

The student may perhaps find himself perplexed by the conflicting statements made by different renowned observers in respect to object-glasses. The illustrious Schleiden said that only a magnifying power of about 500 diameters is useful for scientific purposes, that with our present microscopes we may see whatever we like with a power of 3000, and that only the amplification of an object to the extent of 280 or 300 diameters is produced by the object-glass, all beyond this being effected by the eyepieces with an almost total loss of light. These statements were perhaps formerly true; but they do not apply to the modern object-glasses. The highest modern object-glasses will show minute objects with a power of from 600 to 2500 diameters with the lowest eyepiece, as clearly and well defined as the

ordinary glasses of 1-inch focus will show larger objects; hence enormous improvements have latterly been made in object-glasses,—the increased magnifying power being produced by the object-glasses and not by the eyepieces, by which means the visible images are rendered most distinct and trustworthy; for the object-glass alone produces the structural image of the object, which is magnified by the eyepiece, but the latter elicits no further structures.

According to modern views, about 800 diameters is the magnifying power of the object-glass which will resolve all visible structure. High eyepieces, even to 50,000 diameters, will magnify the images, but will not elicit further structures.

For ordinary useful purposes, the $\frac{1}{2}$ or $\frac{3}{4}$ inch and the $\frac{1}{4}$ inch object-glasses, with the first and third eyepieces, will suffice. With the draw-tube and the third eyepiece, the $\frac{1}{4}$ will magnify 900 diameters, which is sufficient for most ordinary investigations.

Recent investigators with very high powers, especially with immersion-lenses, have brought to light new structures hitherto overlooked; we need merely mention the muscle-rods (Plate 22. fig. 36 *c*), the spermatozoal membrane (Plate 50. fig. 25), and the cilium of *Bacterium* (Plate 1. figs. 19, 20), &c; but all the lenses made by the best makers, both English and foreign, are provided with an immersion-front. These structures, which are very difficult to exhibit with the older microscopes and object-glasses, show the importance of using very high powers, especially the $\frac{1}{16}$ or $\frac{1}{25}$ inch.

Diaphragm.—Most microscopes are provided with a diaphragm. It consists of a circular blackened revolving plate, placed beneath the stage and having a series of circular apertures of different sizes, each of which can be brought successively opposite to the axis of the body of the microscope. It serves to regulate the quantity of light in examining transparent objects; it also reduces the angle of the cone of the reflected rays. It is seldom, however, used, nearly the same effect being produced by the two different surfaces of the mirror.

Revolving Stage-plate.—One of the plates of which the moveable stage is composed is so constructed as to revolve in the same plane upon its axis, whereby an object may also be made to revolve in the same manner. This apparatus, however, has some disadvantages in the older microscopes; for it renders the stage heavy and increases its depth; and the desired effect may easily be produced by rotating the slide with the fingers; moreover it is exceedingly difficult to place the object in the centre of rotation. It is however, provided in the best modern instruments, and is by many considered of importance; the old thickness of stage has also been avoided.

Spring Clamping-piece is intended to fix the slide upon the stage. It is of little use provided the slides are of the proper length, which we have given; if they are longer, the clamp will prevent the accidental displacement of an object in changing the power, &c. It serves, however, to fix the slide in viewing objects by oblique light, when the slide projects beyond the edge of the stage, and to prevent its tilting over.

Forceps are essential for holding opaque objects, such as insects, and viewing them in different positions; to allow of which, the handle of the forceps is made capable of revolving.

The *Disk-revolver* (Beck) is a very useful apparatus. It serves to bring into view all parts of an opaque object, but that which is attached to the disk.

Dark Wells are metallic cups of various sizes, blackened inside, and serving to prevent the reflection of light upon opake objects from below. They are supported in a holder,

moveable in an arm which is inserted into some part of the stand of the microscope. Their purpose is equally well effected by a slide beneath which a piece of black velvet has been fastened by marine glue.

Achromatic Condenser.—This consists of an achromatic object-glass, or set of lenses, placed in an inverted position beneath the stage, usually in a "secondary" stage, and moveable in all directions in its own plane and in the direction of its axis. It serves to condense the light reflected by the mirror to a focus upon the object, and to exclude all extraneous light. It is essential in examining minute objects with high powers; in fact, the structure of many objects cannot be made out without it. In the excellent Gillett's condenser, a rotating diaphragm is placed behind the back glass of the combination forming the condensing object-glass, perforated with a series of apertures of various sizes, some of them being circular, whilst others are annular—the former diminishing or increasing the cone or pencil of rays reflected from the mirror by excluding the lateral rays, the latter admitting only the lateral rays, the central ones being intercepted by the portion of the diaphragm within the ring, so that the angular inclination of the transmitted rays may be increased or diminished at will. In its most improved form it consists of two concentric revolving diaphragms, with central stops, by which the relative sizes of the apertures and stops can be varied; and its angle of aperture is 170° (Powell). In the latest form, it represents a "swinging" substage. The markings upon many of the Diatomaceæ can only be made out when examined by oblique light, as procured by intercepting the central rays, which effect is produced by this modified achromatic condenser. The same effect may be produced to some extent in one of the achromatic condensers of the old form, provided the compound lenses of which the object-glass in the condenser consists are separable, by pasting or temporarily placing a circular disk or "stop" of black paper exactly upon the centre of the plane face of the innermost combination. The diameter of the disk should amount to about two thirds of that of the surface of the combination to which it is applied. The combinations are then fitted together as they were at first. This stop intercepts the central rays, thus diminishing the amount of light transmitted; but this difficulty is easily got over. When the achromatic condenser is used, the flat surface of the mirror should form the reflecting surface, and care should also be taken that the axis of the condenser coincides with that of the object-glass. To ensure this, a small cap of brass having a minute circular aperture in its centre should be fitted to the lower part of the tube in which the condensing lenses are situated. When the object-glass is properly adjusted with regard to the condensing lenses, the field of the microscope will appear black, excepting at a minute luminous spot. This spot must be made to occupy the centre of the field by moving the laterally adjusting screws of the condenser, or the body of the microscope; as soon as this has been effected, the brass cap must be removed. Or Ross's centering-glass may be used: this consists of a tubular eyepiece cap, in which are two plano-convex lenses so adjusted that the image of the aperture in the object-glass, and the images of the apertures of the lenses and diaphragms of the condenser, may all be seen in focus at the same time, and their centricity or excentricity determined.

The focus of the condenser must be made to fall upon the object, which can be effected by raising or depressing the condenser until the window-bars by day, or the lamp-flame by night, are brought into focus; but if the image of these interferes with the view of an object, the condenser must be lowered to displace them.

The paper-stop may be very advantageously replaced by a blackened metallic stop placed

behind the first pair of lenses of the condenser, and screwed into the top of the condenser in the place of the ordinary diaphragm. Neither of these kinds of stop equals in convenience the improved Gillett's condenser, because with the latter the number of rays transmitted or intercepted, and the degree of their obliquity, can be varied by the simple rotation of the diaphragms. The *spot-lens* is also used for the same purpose. This consists of a very convex plano-convex lens, placed beneath the stage, the central rays being intercepted by a stop.

The central stop is generally used when objects are examined with the higher powers. The power used in the condenser will vary greatly according to the kind of object under examination. If a considerable amount of light be required without obliquity of the rays, the condensing power should be lower than that of the object-glass. If great obliquity of the rays be required, the higher the power of the condensing lenses, and the larger their angular aperture, the better. When the achromatic condenser is suitably arranged in regard to centering, and the condensing object-glass or set of lenses is properly selected and adjusted, the structure of minute objects is displayed in a manner with which those who regard the condenser as useless must be utterly unacquainted. Many very delicate objects are rendered most distinct by using the smallest aperture in the diaphragm of the condenser, so that the admitted rays are almost parallel. But this requires a very powerful light.

Extra Eyepieces.—Always one, and mostly two or more eyepieces, or oculars as they are sometimes called, are obtained with the microscope when purchased: but the highest eyepiece which is made should always be procured; for although high eyepieces are so far objectionable that they magnify the imperfections of the image formed by the object-glass as well as the image itself, yet they frequently render parts of structure distinct which are perhaps only just perceptible with a lower eyepiece. Kellner's orthoscopic eyepiece, in which the lower lens is doubly convex, gives a very large and flat field.

Polarizing Apparatus or Polariscope.—This usually consists either of two plates of tourmaline, or of two Nicol's prisms. The latter are generally used, and are preferable on account of their freedom from colour. They are composed each of two half-rhombs of calcareous spar cemented together so as transmit only one image. The prisms should appear perfectly clear and colourless, and free from scratches and veins; and when, on holding them to a light, the uppermost is rotated so as to occupy a particular position with regard to the other, no light should be transmitted through them.

The polarizing apparatus is useful in bringing to light certain peculiarities of structure which cannot be detected in any other way; and is particularly useful in the study of minerals (ROCKS). A substitute may be made of two crystals of the iodo-disulphate of quinine, dried upon and cemented to circles of thin glass. In use, one is placed beneath the object, and the other on the top of the eyepiece.

Spectroscope.—The spectroscope, as applied to the microscope, is a somewhat expensive apparatus, and requires great practice in its application. It is, however, most important in many investigations. See SPECTROSCOPE.

Side Condenser.—This consists of a large doubly convex or plano-convex lens, or "bull's-eye," of short focus, 2 or 3 inches, mounted upon a brass arm, which slides up and down a rod placed perpendicularly in a stand. The arm should be capable of being lengthened, and the stand should be so broad and heavy that there need be no fear of its being overturned.

Its use is to condense the light upon opaque objects. When used, it is placed between the object lying upon the slide under the microscope and the lamp or other source of light, which should be about 6 or 7 inches from the object, the plane surface of the lens being at right angles to the direction of the rays of light, and next the object; and the lens must be brought so close to the object that the focus falls upon the latter. Sometimes a "small condensing lens" is used to concentrate the light already transmitted through the large condenser: this is usually fixed to some part of the microscope. A doubly convex lens of much longer focus than the bull's-eye lens, about 7 or 8 inches, will be found very useful for condensing the light upon the mirror when the achromatic condenser, stops, &c. are used with the highest powers. The arm of the bull's-eye lens may be adapted to hold either or both of the lenses.

Amici's prism is sometimes useful for throwing very oblique light through a transparent object. It consists of a flattened-triangular glass prism, the two narrower sides of which are convex. The third and broadest side forms the reflecting surface. The prism may be attached to a separate stand, or to the secondary stage. It is sometimes mounted on a pillar placed beneath a large brass slide, perforated in the centre. A triangular prism mounted in either of these ways forms a Reade's prism, and is used in the same manner. Amici's prism exerts a condensing as well as reflecting action.

Lieberkühn.—Some opaque objects may be well illuminated by a lieberkühn or silver cup; by which the light, first reflected by the mirror upon the concave surface of the cup, is afterwards reflected upon the object. It is not adapted for higher powers than the $\frac{1}{4}$ inch.

Wenham's Parabolic Reflector.—The discovery of the importance of excluding the central rays of light, and using a central stop for this purpose, is due to F. H. Wenham, who invented an apparatus in which this principle is taken advantage of. It consists of a brass tube fitted beneath the stage in the place of the ordinary achromatic condenser, terminated above by a hollow truncated cone the perpendicular section of which forms a parabola, with an internal polished silver reflecting surface. At the base of the parabola is placed a disk of thin glass, in the centre of which is cemented a dark well. In use, the central rays are stopped by the dark well, whilst the lateral rays, passing up the tube, impinge upon the parabolic surface, from which they are reflected upon the lower surface of the object. This apparatus, as modified by Shadbolt, is constructed of a solid cylinder of glass terminating above in a cone the surface of which has the form of a parabola and replaces the silver reflecting surface—and is the form now generally used. In objects viewed under this or any other form of black-ground illumination, the light reaching the eye is all reflected from certain suitably inclined surfaces of the object. This may be proved by placing a polarizer beneath the reflector, selecting as the object some small strongly polarizing crystals. On applying the analyzer, no colour will be seen, showing that the light has not passed through the object. Hence care must be taken in drawing conclusions from the appearances.

Brooke's Reflecting Apparatus.—The purpose of this is to illuminate objects by reflected light, so that they can be examined with the highest power. It consists of two parts; the first is essentially the same as the apparatus proposed by Wenham. The second consists of a small, flat, circular metallic mirror (a flat lieberkühn), perforated to admit the lower end of the object-glass, upon which it slides, and so arranged that the reflecting surface is in the same plane as the lower surface of the object-glass. When in use, the light is

reflected by the parabolic surface upon the plane reflector, and thence upon the upper surface of the object. This apparatus has lately given place to the next-mentioned.

Beck's Opaque Illuminator, which is a valuable piece of apparatus, is constructed thus:—A short screw-tube, or adapter, with an aperture in one side, is fitted between the end of the body and the top of the object-glass. Within the tube is a circle of thin glass, set obliquely, so that the light entering the side aperture is reflected by the circle upon the surface of the object, and passes upwards to the eyepiece. This may be used with the $\frac{1}{10}$ to $\frac{1}{50}$-inch immersion-lenses; and with it the hexagonal markings of *Pleurosigma angulatum* are distinctly seen, and the lines of fracture running through the areolæ (Moorehouse).

Tolles's Illuminator consists of a prism inserted in the side of the object-glass, between the front and middle combinations, so reflecting the light entering by a side aperture upon the object. See also ILLUMINATION.

A number of points in regard to the colour of objects, distinction of pigment-granules from minute air-bubbles, &c. may be decided by these pieces of apparatus. In questions of elevations or depressions of surface, conclusions must be based upon the analysis of the formation and arrangement of the shadows, and not upon the general appearance, because it is well known that objects, or parts of them, usually appear larger and more prominent in proportion to the amount of light reflected by them to the eye. Hence, for instance, little depressions, which are in fact extensions of surface, by reflecting more light than the surrounding flat or nearly flat surfaces, would appear very brilliant and luminous, and thus resemble elevations.

Camera Lucida, and steel disk or *Mirror* of Sömmering.—One of these is requisite for drawing from the microscope. The camera lucida resembles that commonly used in sketching landscapes &c., but is provided with a fitting adapting it to the eyepiece. The mirror of Sömmering is a plane mirror of polished steel, less in diameter than the pupil of the eye, supported opposite the focus of the eyepiece by a small steel arm attached to a split ring which grasps the eyepiece by a spring-action. There is one disadvantage attending the eyepiece of Sömmering, viz. that it inverts the image of objects, which the camera does not. When either of these is used, the body of the microscope must be placed horizontally, and the axis of vision be directed perpendicularly; the image of the object will then be seen upon the table, and may be traced with a pencil. In using the camera, it must be remembered that the size of the object will appear greater as the distance between the eyepiece and the table is increased; hence it is best always to place the microscope in one and the same position when about to use it for drawing, so that the extent to which the objects are magnified by the same power may always be the same. The pin mentioned at page xv is invaluable for this purpose. By placing a micrometer-slide upon the stage, and comparing the magnified image of the divisions with those on a known measure, such as a graduated rule, the magnifying power can always be checked, and any error arising from varied distance determined.

Beale's neutral-tint glass reflector is often used as a camera, and is inexpensive.

In using either the camera or the mirror of Sömmering, the eye must be kept exactly in one position; otherwise the image of the object will move. Also the field and the paper must be illuminated to nearly the same extent. One of the screens mentioned at page xxviii is very useful for excluding extraneous light.

Erecting-glass (Lister's). This consists of a brass tube, furnished with a meniscus at

the upper and a plano-convex lens at the lower end. It is screwed into the diaphragm of the body of the microscope, or that of the draw-tube. It erects the images of objects, and serves, with a low object-glass, to reduce the magnifying power at pleasure, and to facilitate dissection under the microscope.

Live-Box and Growing-Slide.—The live-box is an apparatus in which portions of liquid containing infusoria and other small animals or plants can be confined so as to prevent evaporation and allow of their being watched in a living state.

A better apparatus, however, for this purpose is my growing-slide. This consists of a piece of stout plate-glass, 5 inches long and about 2 wide. A circular aperture, of about the diameter of a test-tube, is made near one end of it. A little glass cup, formed of a portion of a test-tube cut off three fourths of an inch from the closed end, and slightly less in diameter than the aperture, is then fitted into the latter, either by pieces of cork, or by a rim consisting of a glass ring forming a neck to the cup, or in any other way. The cup should project about one fourth above the surface of the slide; and at one portion of its margin a little groove should be ground, in which two or three threads of a lamp-wick can be placed. The cup should be covered with a circular plate of thin glass, larger than its mouth, and prevented from falling off by a disk of cork fitting the mouth and fastened to the plate by marine glue; or the cup may be closed with a common cork, the only objection to this being that the mouth of the cup is apt to split. The manner in which the slide is used is this:—Supposing it is wished to follow the changes undergone by some minute alga or infusorium which has been detected in a drop of liquid, it is placed upon a slide and covered with thin glass; the slide is then placed upon the growing-slide in such manner that the longer dimensions of the two are in the same direction; a little ledge consisting of a strip of glass fastened by marine glue to the growing-slide will serve to rest the slide against, and prevent its becoming displaced. Distilled water, mixed with a small proportion of the water in which the organism was living before being transferred to the slide, is next put into the cup, and a few threads of lamp-wick cotton, thoroughly moistened with distilled water, are then so placed that one end is immersed in the cup whilst the other is brought into contact with the edge of the liquid in which the object is immersed. Thus, as the water evaporates from beneath the thin glass, the threads will afford a continuous supply, and the threads will not become dry until the whole of the liquid in the cup has become absorbed by them and evaporated. In this way we obtain the requisite conditions for the continued growth of aquatic organisms. Care must be taken, however, that the thin glass presses but slightly upon the object, and that the threads come as little as possible into contact with the portions of the slide lying between the cup and the thin glass. If the thin glass cover to the cup fit tightly, and the thread be passed through the notch in the cup, no loss will take place by the direct evaporation of the liquid in the cup. In many cases a modification of this slide is arranged so that organisms can be kept in a warm liqnid; this is very useful in examining amœboid movements of the blood-corpuscles, leucocytes, &c. Several varieties of this have been devised (GROWING-SLIDE).

Compressor, an instrument for the regulated compression of a minute object. The same effect can be produced by a well-made live-box, or by pressure directly applied to the thin glass covering an object by the handle of a mounted needle.

Cabinet.—A box or cabinet, containing a number of drawers, will be requisite for holding the objects. Each drawer should be numbered or labelled to facilitate reference. The objects should lie flat in the drawers, so that each may be found when required without

loss of time. The cabinet should be furnished with two folding doors, so as to exclude dust as much as possible. It should also be made of thoroughly seasoned wood, oak or mahogany being the best; if made of deal or cedar, the vapour of the volatile oil of the wood will insinuate itself beneath the thin glass cover and the slide in those objects which are mounted in the dry state, and, condensing upon them and the objects, will obscure and spoil them.

It may be remarked here that the names of objects should always be written upon labels pasted (not gummed) to the slides, not merely upon the slides with a diamond. The colour of the labels should be different for each kind of object; or if the labels be composed of white paper, they should have a coloured margin; thus those of the Desmidiaceæ may be green, the Diatomaceæ yellow, &c., so that the various slides, when accidentally mixed after comparative examinations, can be readily replaced in their respective drawers.

Bell-glasses.—The microscope when in use, either constant or occasional, should always be kept under a large bell-glass, the base of which fits into an annular groove made in a circular flat wooden stand. In this way it is kept from dust, and the trouble and wear and tear consequent upon putting it into a box is saved. Moreover, thus protected, an object under examination can be left without fear of injury or disturbance, and be also preserved from dust.

Several smaller bell-glasses of various sizes should also be kept at hand, under which any objects which it may not be convenient to mount for a time, or the examination of which may not be completed, can be protected.

Slides.—These are ordinarily made of glass about the thickness of common window-glass; their length is usually 3 inches, and their breadth 1 inch. The old length was $2\frac{1}{2}$ inches, which I prefer, as the longer slides, with a large number of objects, take up so much room; but as the aperture in the stage has been enlarged in the modern microscopes to allow of the passage of the parabolic reflector, the Amici's prism, &c., if the old size be retained the slides will drop through the stage: this we remedy by an additional brass plate. Where the objects are very large, the slide must be proportionately large, and its thickness greater than usual. The slides should be made of colourless glass, so as not to interfere with the appreciation of the colour of an object. And they should be flat; otherwise the parts of the object will lie in different planes, and every motion of the slide will require new adjustment of the focus. The edges are best somewhat ground on a copper plate with emery, to prevent injury to the fingers or scratching the stage-plate. Very delicate structures require to be examined and mounted upon thin glass. The slides may then be made of wood, sheet zinc, or tin-plate, with a circular aperture in the middle, upon which a piece of thin glass is cemented; or slides of 9–10-oz. crown-glass may be used.

Covers.—Comparatively few objects can be viewed in the dried state; hence they are most frequently immersed in some kind of liquid. To prevent the evaporation and condensation of this upon the object-glass, and to reduce the thickness of the layer of liquid to a minimum, the object is usually covered with a piece of thin glass. The form of this cover is either square or circular, and the thickness from about the $\frac{1}{50}$ to the $\frac{1}{100}$ of an inch, or even less. These covers are usually kept already cut by the microscope-makers and those who sell objects. Before use, they are best allowed to remain immersed in water for some time. Care is required in wiping this thin glass. It is usually effected by holding the cover at two opposite points of the margin between the finger and the thumb of the left

hand, and rubbing the surfaces with a fold of a cloth, leather, or silk handkerchief covering the same parts of the right hand. But the thinnest glass cannot be wiped in this way without being broken. This requires to be held at the edge by the finger and thumb of the left hand applied to the flat surfaces, and to be drawn slowly through the fold of the cloth in the hand. A very thin layer of mica is useful as a cover with the highest powers, as it prevents the risk of scratching the object-glass, the lower surface of which is often flush with the edge of the brass mounting.

Dipping-tubes.—These are glass tubes varying in length from about 5 inches to a foot, and in calibre from $\frac{1}{8}$ to $\frac{1}{2}$ an inch. They are cut of the proper length by a three-square file, and the ends gently fused in the flame of a spirit-lamp. One end is then coated outside with sealing-wax and spirit, or some other coloured liquid, so that the same end may always be used for the same purpose. They are of use for removing objects from water or other liquids in which they may be contained. Suppose, for instance, it is required to examine some deposit lying at the bottom of a liquid, or an object suspended: the fore finger of the hand in which the tube is held is placed upon the upper end of the tube so as to close it; the other end is then immersed in the liquid and brought into contact with, or as near as possible to the object, and the finger removed from the upper end. Hydrostatic pressure then forces the liquid, and with it the object, into the lower part of the tube, and it can be transferred to a slide. When a tube of narrow calibre is used, the liquid and object are retained within the tube by capillary attraction; they must then be removed by gently blowing at the upper end, the lower end being placed upon the slide. The use of colouring one end of the tube is, that the application of the mouth to the end of the tube which has been immersed in some offensive liquid, as fœtid water, &c., may be avoided.

These tubes should be kept in a glass of distilled water, with the coloured ends uppermost.

When a large tube is used, as in removing the larva of an insect, a tadpole, &c., the quantity of liquid removed is also large, and will be more than is required on the slide. The tube should then be emptied into a watch-glass, and the object placed upon the slide or in the live-box by a camel's-hair pencil.

Forceps are in constant requisition for taking hold of minute objects, dissecting, &c. Those used for medical purposes (common steel dissecting or surgical forceps) are best. There are three points to be attended to in the selection of them. They should not be too short, *i. e.* less than four inches in length at least; the spring- (separating-) action should be very feeble; and the points should be perfectly flat and smooth where they come into contact. If forceps are shorter than the above length, they are not easily held steadily; if the spring-action be strong, on holding an object, as in dissection, with the forceps, the attention being perhaps directed to the scalpel, needle-points, &c., the blades of the forceps separate, and the object escapes from their grasp. If the forceps have teeth or are grooved, perhaps after laying an object out upon a slide under water, or elsewhere, a portion of it becomes entangled in the teeth, and the whole displaced. Surgical "tenaculum-forceps" are very useful occasionally in injecting. These forceps lock by their own spring-action. Supposing, then, the injection is escaping from the orifice of some vessel which has been overlooked and no assistant is at hand, on including the open end of the vessel between the ends of those forceps, which may then be left hanging, it is firmly fixed, and the operator has both hands disengaged to tie it; in fact, these forceps are

indispensable to the injector. They should be short, and not heavy; otherwise the vessel may be torn by their weight.

Surgical "dressing-forceps" are also frequently of use; and long "œsophagus-forceps" with scissor-handles are serviceable for removing portions of plants &c. from large jars or glass vessels.

Needles.—For separating the parts of minute objects, fine points are requisite; these are found in common needles of moderate size fixed by one end into the handle of a water-colour brush. These are easily prepared: the needle is cut in half by cutting-pliers; the blunt end is then forced into the stick, about half an inch in length being left projecting. Surgeons' "cataract-needles" ground down are elegant instruments of this kind, but they require to be shortened. For the minute dissection of objects, the mounted needles require pointing on a hone.

A stout sable-hair or fine bristle, inserted into a slender wooden handle, is frequently of use in isolating minute bodies, as Diatomaceæ, which would be broken by any other instrument. It is used thus: suppose we have a number of *Naviculæ*, or the like, in a bottle, mixed with other bodies, and we wish to isolate one for preservation. A small quantity of the deposit is taken up with a dipping-tube, and allowed to escape upon a slide in such manner as to form a narrow stripe upon it. This is then examined with the lowest power with which the object can be distinguished, and one near the margin of the liquid stripe is selected, and may easily be removed with the mounted bristle (under the microscope) beyond the margin of the liquid. The remainder of the liquid is then wiped away with a cloth, a little distilled water added to the small quantity of liquid left containing the object, and the latter moved with the bristle into the middle of the slide. The liquid is then driven off by heat, and the object is left on the slide ready for mounting. Or, when the matter is dried upon the slide, any one of the minute objects being lightly touched with the dry bristle will adhere to it; and by gently pressing or rotating the bristle upon the middle of a new slide, the object will readily be transferred to the latter. The Diatomaceæ may be easily isolated in this way.

Knives.—Ordinary dissecting-knives or scalpels. The handles should be sufficiently large to allow of being firmly held.

A particular and most useful kind of knife for producing thin sections of soft bodies is that known as "Valentin's knife." It consists of two or sometimes three blades with their flat surfaces parallel, set in a handle. The blades can be fixed at any distance apart, according to the thickness of the section required. It is drawn across and through the substance, from heel to point; the section remains between the blades, and is then removed, either with forceps, or the blades of the knife are opened under water, and the section floated upon a slide immersed in the liquid. In the latter case, the action of the water upon the tissue must not be overlooked. Valentin's knife is absolutely indispensable in the examination of animal bodies. Some sections, especially of plants, are best made with a razor. Many sections can only be made by the aid of the "section-cutter" or microtome, which is described under PREPARATION.

Black and white Disk.—A disk 3 or 4 inches in diameter, made of seasoned wood, and upon one face of which a piece of white paper or card-board has been fastened by paste or glue. One half of the paper or card-board is coloured black; the other is left white. This is very useful in dissecting or separating minute portions of tissues; if these are white, they become much more easily distinguished than usual when placed (on a slide) over the black part of the disk; if they are dark, over the white portion.

Leaded cork.—Some structures require to be dissected under water, as, *e. g.*, those of insects &c. These should be fixed with pins upon a piece of cork, beneath which a plate of lead, corresponding in size, has been fastened. In many cases it is advantageous to dissect these tissues under the simple microscope. An aperture may then be made in the lead and cork, and the tissue or structure stretched across the aperture, so that the light may pass through it; or it may be illuminated as an opaque object by the aid of the bull's-eye.

A trough, composed of five pieces of glass cemented together with marine glue, four for the sides and one for the bottom, will serve to hold the water and the leaded cork.

Evaporating Dish or Saucer.—It is advisable to keep one of these, with a flat bottom, always at hand filled with distilled water, in which slides and covers that have been used may be immersed. The remains of objects which have been examined are thus easily separated from the glasses, and there is but little trouble in wiping the latter clean. If held under a gentle current of water, all remains of tissues or test-liquids may be washed away from the dish—the glasses, from their gravity, remaining at the bottom.

Test-box.—A wooden box, holding from six to a dozen or more test-bottles, is indispensably requisite. The box must be divided into partitions corresponding to the size of the bottles, and the latter must be wedged between these partitions so that the stopper can be removed without fear of disturbing the bottles. The box should be covered with a lid furnished with hinges, so that no room may be required to place the lid when the box is opened. The bottles will vary in size according to option; but they should be of at least 1-ounce capacity. Each should have a stopper so prolonged as nearly to reach the bottom of the bottle, its form being either conical or fusiform. The advantages of this form of stopper are, that a mere trace or several ordinary drops of the reagent may be applied to the object as required. If a very minute quantity be desired, the lower part of the stopper is allowed to touch the inside of the neck of the bottle when it is withdrawn; and if a larger quantity be required, this proceeding may be avoided. Each bottle should be labelled; and a label should also be placed upon the upper end of the side or partition of the box near to the bottle, so that the nature of the contents of each bottle may be ascertained without removing it from the box. The general advantages of this apparatus are, that the quantity of reagent required can be obtained to the greatest nicety, and it can be added to the exact spot required with one hand only, so that the other can be employed to hold the slide and object &c.

Reagents or Test-liquids.—Some of these should be kept in the test-bottles; but larger quantities should also be kept in other stoppered bottles. We give a list here of those test-reagents which are most frequently required; the method of preparing each, the strength, &c. will be found under the respective heads.

1. Sulphuric acid. 2. Nitric acid. 3. Acetic acid. 4. Caustic potash. 5. Chloride of calcium. 6. Aqueous solution of iodine. 7. Oil of turpentine. 8. Glycerine. 9. Acid nitrate of mercury (Millon's test-liquid). 10. Distilled water.

Benzole and alcohol or methylated spirit should also be kept at hand. Chromic acid should be preserved in a wide-mouthed stoppered bottle, and its solution prepared when requisite, as it easily becomes decomposed by dust &c.

Troughs are flat, oblong glass boxes, without lids. They are made of pieces of glass cemented together by marine glue, and are used in examining the larger aquatic plants or animals in a living state, also in mounting objects.

Divided Scale.—A metallic or ivory scale divided into 100ths &c. of an inch, is indispensable in micrometric admeasurements (see MEASUREMENT). The metal or ivory should extend beyond the graduated portion.

Micrometer.—A glass slide with fine lines scratched upon it with a diamond, these being $\frac{1}{1000}$th of an inch apart, is absolutely requisite. Another, with coarser divisions, is also required to be placed in the eyepiece, for making measurements (see MEASUREMENT).

A rectangular *brass table*, with two legs at one end and one at the other, is useful in macerating objects upon slides in chemical reagents, oil of turpentine, or Canada balsam, and in mounting objects. It is heated by a small spirit-lamp placed underneath.

Ring-Net.—A very useful piece of apparatus for collecting Desmidiaceæ, Diatomaceæ, &c., where entangled amongst Confervæ &c., or forming crusts or films upon other aquatic plants, consists of a brass or wooden ring about 4 inches in diameter, furnished with a groove round its circumference, in which also a radial aperture exists, through which the end of a stick may pass. A piece of very fine muslin, rather larger than the ring, is then laid over it, and the margins of the muslin fixed in the groove by means of a vulcanized Indian-rubber band. Or this apparatus may be so modified, that the muslin is fixed by means of an inner ring, adapted to the outer, but incomplete at one point of its circumference, and with a projecting rim to prevent its passing through the outer ring. Thus we have a kind of strainer; and by using several pieces of previously wetted muslin in succession, a large number of the minute organisms may be separated from the water. The pieces of muslin may be brought home, folded up, in wide-mouthed bottles, separately, or several in one, according as the organisms are obtained from one or several waters. In this way we save carrying a large quantity of water. The pieces of muslin are afterwards opened and placed in jars of filtered river-water, and exposed to the light, when the organisms will become detached.

A simple microscope, or some apparatus which will allow of dissection with the aid of lenses, is essential, although the erecting eyepiece or the erecting-glass (p. xxii) will answer the same purpose. It is of little consequence which be selected, provided a large and firm sloping arm-rest be furnished on each side of the stage. Either doublets or the lower powers may be used. Some of the modern simple microscopes are binocular.

Leather Case and Collecting-Bottles.—The Diatomaceæ, Desmidiaceæ, and other smaller Algæ, as also the Infusoria, require to be collected and brought home in bottles. These should be of about 1 or 2 ounces capacity; and, for portability without risk of being broken, they should be packed in a case made of stout leather, with a separate space for each bottle. The whole will pack up in the form of a book.

Having given a sketch of the most important pieces of apparatus, we will say a few words upon the illumination.

Illumination.—The best light in general for microscopic purposes is undoubtedly daylight, or that of the sun reflected from the clouds; and this is certainly the light which can be borne for the greatest length of time without injury to the sight. The position of the observer is of importance; it should be such that the window is on his left hand, or even the back slightly turned towards the window. The advantages of this position are great; for then but little light will enter the eyes directly from the window, and it is of the greatest importance, during a microscopic examination, that the least possible amount of light should be admitted to the eye, from any source, besides that transmitted through or reflected from the object. In drawing also with the camera lucida this position should

be strictly observed; for all extraneous light which would interfere with the distinctness of the image is thus excluded, and the shadow of the pencil and hand does not interfere with or obscure the sketch in progress, which would be the case if the observer's right hand were towards the window. But in daylight the light entering the eye from the window, even in the position above mentioned, will interfere with the observation, unless a preventive be employed, which is to place a screen, either supported upon a stand or fixed to the upper part of the body of the microscope, between the eye and the eyepiece of the microscope and the light. This screen may be made of card-board or thin wood, covered with black velvet. If it be fixed to a moveable arm, like the lens of the side-condenser, it may be easily placed in any convenient position. If to be fitted on the microscope, it may be constructed thus: a piece of stout card-board, of about the size and shape of one of the plates of this work, should have the corners rounded off, and should be bent at a right angle at about the lower one-fourth; a hole being cut in the middle of the smaller portion, of a size just to fit the top of the body of the microscope, a short tube of card-board is then made by sewing or pasting; and this, being fastened in the same way to the circular aperture, serves to keep the screen in position. The whole is then covered with black velvet. When used, the long flap should be placed towards the left side; it then shelters the eye and upper part of the eyepiece from the light. A screen of this kind should always be kept upon the microscope; for it is of the greatest service. A tube made of a roll of card-board, fastened to the inside of the angle of the screen described above, will serve to fix it to the stem of the side-condenser; it may then be made to slide upon this axis or stem at pleasure. It is hardly possible to use the high powers of the microscope by daylight without a screen of this kind.

But few persons have the opportunity of using daylight for microscopic researches, and with the highest powers ordinary daylight is by no means sufficient; hence artificial light of some kind is called into requisition; and the most common source of this is an Argand-lamp (Silber's) with oil; used with or without a side-condenser. For ordinary purposes this answers well, although the best for examining Diatomaceæ &c. is a paraffine-oil or camphine lamp, especially when stops and very high powers and eyepieces are used, whereby a large amount of light is intercepted. A cheap common benzoline lamp with a round or, better, a flat wick, is very advantageous, even with the highest powers ($\frac{1}{8}\frac{1}{0}$th Beale); the direct light being used. In Fiddian's lamp, the flame is enclosed in a metallic case, so resembling a bull's-eye lantern, the light escaping from a round orifice only; hence no extraneous light can reach the eye. The lamp must slide up and down the stem, so that it can be placed at any height; and it should be furnished with a shade, also moveable. A white-cloud earthenware or enamel shade is often used. Norman's paraffine-lamp, and Collin's Bockett lamp, with an attached bull's-eye, and How's lamp, are good lamps. An improved lamp, for illumination and centering with high powers, is described by Dallinger (*M. Mi. Jn.* 1876, xv. p. 165).

Much of the success with which the structure of an object is displayed will depend upon the manner in which the light is thrown upon or transmitted through it. In general the more light that can be condensed upon opaque objects the better; and when the various parts of such objects are of different colours, the more direct the light and the greater the angular aperture of the object-glass, the more clearly will the parts be distinguishable; while in certain opaque objects which present questionable elevations or depressions on

their surface, great obliquity of the incident light is essential. With transparent objects it is sometimes desirable to diminish the amount of light more or less; which may be done, either by means of the diaphragm, by using the flat instead of the concave face of the mirror, or by inclining the mirror to one side. It must not be forgotten, in determining the cause of the better display of an object by the substitution of a less amount of oblique light for a larger amount of direct light, that it need not necessarily arise from the obliquity; for in many instances the cause is simply the diminution of light, whether direct or oblique being a matter of indifference. When the mirror has only one reflecting surface, the amount of light may be diminished by removing the lamp to a greater distance from the mirror, or turning this somewhat on one side. But the difficulty usually found consists in the amount of light being too small instead of too great. This may be overcome by attention to the following circumstances: the mirror must be placed as near the lamp as possible; if it cannot be brought within a few inches of the lamp, the shallow bull's-eye condenser must be made to condense the light upon the mirror: with the object-glasses of high powers the achromatic condenser must be used; and the lower the power of the condensing lenses, the greater will be the amount of light transmitted. The lined appearances presented by many objects, require for their exhibition very oblique light, which may be obtained by first raising the mirror as near as possible to the plane of the stage, and then bringing it as much to one side or the other of the stage as can be done. Nachet's, Amici's, or Reade's prism is very useful for producing the same effect in a greater degree; large angular aperture in the object-glass is also very advantageous under these circumstances, because it will allow of the admission of rays of such a degree of obliquity as could not enter one of smaller aperture.

In cases where still more oblique light is required than can be obtained in any way by reflection from the mirror, this must be turned aside, and the direct light of the lamp used, thus: clamp the slide so that the object projects beyond that side of the stage which is nearest the lamp. The body of the microscope is then rotated so that the object-glass is over the object and fixed by the milled head; the axis of the body being then directed to the light, the object may be thus brought into focus; and by moving the lamp around the microscope, light of any obliquity may be made to pass through the object. This is a simple way of obtaining the most oblique light, and as the light comes directly from the lamp, there is no loss from reflection, as in the use of prisms. By a little variation of this arrangement, the light may be made to fall very obliquely upon opaque objects, especially if uncovered. In many instances the use of the direct light of a lamp is highly advantageous, and may be applied even when the highest powers are used. It has an advantage over that of the mirror, inasmuch as when the latter is used, the light entering the object is derived from two sources, viz. reflection from the outer and the inner surface of the mirror; whereby two images are formed, confusing each other; while with the direct light, the image is single and the definition finer.

Many years ago I suggested a method of remedying the defects of artificial light, or that ordinarily used to replace daylight. The well-known glare attending lamp- or candle-light, and the predominance of a yellow colour, so visible when compared with daylight, render it very unfavourable for microscopic purposes. It was proposed to mix some substance with the combustible which during its combustion evolved a light of the colour complementary to (or forming white light with) that predominant in the artificial light, or to pass the light in its passage from the artificial luminary through a piece

of glass of such colour as to intercept or check the objectionable rays. As these rays are of a yellow or reddish-yellow colour, the colour of the glass must be blue or purplish blue; but the exact shade must be obtained by experiment. Thus: the lamp, or whatever source of artificial light it may be, is lighted in the daytime, and the light transmitted through the microscope by reflection in the ordinary way, when its intensely yellowish colour is very obvious. Pieces of glass of different colours are then separately placed at right angles to the path of the rays from the lamp to the mirror, either close to the flame (in the form of an ordinary lamp-glass), upon the face of the mirror itself, beneath the stage, or in an extra head of the side-condenser. If the glass be of the proper tint, and be placed at the proper distance from the light, and in the proper situation, the field will appear as white as the light of the clouds, which may be easily proved by altering the inclination of the mirror, so as to reflect the light of the clouds and the lamp alternately.

It may be remarked that the nearer the coloured glass is placed to the flame the less apparent effect is produced, *i. e.* the more will the yellow colour be perceptible, and *vice versâ*. If the field still appear yellow, the glass is not of sufficiently deep colour; if it appear blue, the colour of the glass is too deep. The first method, or that of mixing some substance with the combustible (oil, tallow, &c.) capable of evolving a light of the requisite tint to form white with the yellow of the artificial light would be far preferable to the latter method; but I am not aware that any experiments have been made to carry out this idea. It would have two great advantages, viz. that there would be no diminution of light, and that the entire apartment would be illuminated by a light equivalent to that of ordinary day. The second method has one objection, which is, that it intercepts a large quantity of the light, so that in the examination of those objects with high powers which require intense illumination, or where much of the light is arrested by stops, it is decidedly objectionable. The advantages which the use of the blue glass possesses are, that it softens the light very much, and that it enables the observer to discriminate between colours as in ordinary daylight.

A few years after the publication of the above method, a patent was taken out for the construction of lamp-glasses of a blue colour; but they are of little service, merely slightly softening the light, or intercepting a small proportion of the yellow rays. Perhaps, some day, a small electric lamp, worked by clock-work, will be invented.

The proper way would be to "flash" the suitably tinted blue glass upon one side of a pale blue lamp-glass, so that, by simply turning the glass round, the light might be transmitted through either of the differently coloured portions. Rainey's "Light-modifier" acts upon this principle. Numerous other pieces of apparatus and ingenious contrivances will be found described and mostly figured in the last edition of Carpenter's 'Microscope,' or in Beale's 'How &c.'

The illumination is of importance to the microscopic observer in another sense, *i. e.* in regard to the injury of sight. The great point here is to avoid too powerful a light. An eminent French philosopher became blind in experimenting upon the duration of powerful impressions upon the retina. In some instances, sun-light has been used in microscopic investigation; the greatest care must then be taken to use screens or diaphragms to temper the light.

II.—GENERAL METHOD OF DETERMINING THE STRUCTURE OF MICROSCOPIC OBJECTS FROM THE APPEARANCES WHICH THEY PRESENT UNDER VARIOUS CONDITIONS.

Microscopic and histological Appearance, Structure, and Analysis.—Before proceeding to this, let us define what is meant by the structure of a microscopic object. If we take a piece of the free end of the finger-nail, and examine a thin transverse section of it under the microscope, we find it to present numerous shorter or longer dark and somewhat irregular lines running nearly parallel to the surfaces. These appearances do not vary essentially whether it be examined in the dry state, or immersed in water or oil of turpentine.

But when it is moistened with solution of potash, and allowed to remain so for some time, or the slide is gently heated, it becomes entirely resolved into a number of nucleated cells; and by watching the gradual action of the potash, it is easily seen that the cells were originally flattened and arranged in layers, which layers produced the lined appearance mentioned above (see the article NAILS). Now which is to be considered as representing the structure of the nail? the first or the second of the above results? Undoubtedly the second. The expressions microscopic structure and histological structure are used very indefinitely, and often synonymously; the former may very conveniently be restricted to signify the apparent structure as determined with the aid of ordinary mechanical means; whilst the latter may designate the true structure in relation to development. It may at first sight appear very unnecessary to make any distinction between the two; but it is really very important, and many of the descriptions of the structure of bodies, given in books, refer only to their microscopic structure.

The determination of the histological or true structure is often very difficult. Frequently a week or a month must be devoted to the determination of a single point. Take the instance of a hard structure—a piece of the skeleton of one of the Invertebrata. A few sections may exhibit cells, laminæ or fibres, according to the preconceived notions of the observer; whilst the histologist will not express an opinion until the inorganic matters have been removed by long maceration in acid, the calcareous salts thoroughly washed away, and attempts have been made to resolve the organic basis into its histological elements by appropriate means. This may require very many experiments to be made, and no mean knowledge of particular branches of science for guidance in the selection of appropriate agents requisite for their performance. We shall have frequent occasion to use the above words in the restricted sense; hence this should not be forgotten. The word analysis will have the same meaning as that generally attributed to it, the ultimate products being morphological.

A general method of determining the structure of objects can hardly be laid down; it must vary so greatly according to the nature of the objects and their size. The first point is to render them transparent, if not already so. This may frequently be done by immersion or maceration, if dry, in water, glycerine, or oil of turpentine. But the solvent power of the liquid must be borne in mind; for the organic principle aleurone was overlooked for years from its being soluble in water, in which the sections of the albumen of seeds containing it were immersed to render them transparent. Sometimes the aid of heat is necessary; and objects may even require to be boiled in these liquids, either upon a slide placed upon the brass table over the flame of a spirit-lamp, or in a small tube. Sometimes

sections require to be made, and these treated in the same manner. If soft, their elements may be separated by the aid of needles; sometimes pressure will answer the same purpose.

When the object is very minute, it will frequently be desirable to examine both sides of it with high powers. Hence it must not be placed upon an ordinary slide, on account of the thickness of the latter, but it must be supported upon, and covered by thin glass. The best plan is to keep a number of slides of thin wood or tin, each having a piece cut out of the middle. A thin glass cover, rather larger than the aperture, should then be cemented by marine glue or Canada balsam to the slide; the thin glass cover is then applied as usual.

If the object be very small and its structure very delicate, it must be crushed, so that some of the fragments may lie perfectly flat upon the slide. See also the article PREPARATION.

The points to be determined in regard to the different parts of an object, however, may be best treated separately.

The examination of a microscopic object must comprise:—*a*, the *microscopic analysis*, including—1, the form; 2, the colour; 3, the structure of the surface; and 4, the internal structure: *b*, *histological analysis*, in the sense already explained: *c*, the *qualitative chemical composition*: and *d*, the *measurement*.

A. MICROSCOPIC ANALYSIS.

1. *The Form.—a.* This is usually judged of from the outline as seen by transmitted light, and often erroneously. Where a low power is used, the upper surface of an object and its sides are mostly simultaneously visible; but under a high power, only those parts lying within a very limited vertical range, or in the same plane, are visible at one focus, and the parts lying in planes above or below this can only be brought into view by altering the focus: hence the views of objects under high powers correspond to views of transverse sections of the same objects made through various horizontal planes; and as the margins of objects are usually more distinct by transmitted light than the upper surface, spherical or rounded bodies frequently appear flattened. When several bodies of the same kind are visible in the field of the microscope, some will almost always be found lying upon their sides; and even when the objects are greatly flattened, some will mostly be found lying on edge, presenting the side view.

b. But as there may be uncertainty in regard to the relation of these bodies to each other, the only safe method in forming a conclusion is to cause them to revolve or roll over, so that all their aspects may be distinguished. This is in general easily accomplished: if the object be already immersed in liquid, the inclination of the stage will answer the purpose; or a little benzole, naphtha, alcohol, or some other volatile liquid in which they are insoluble, must be added. The currents produced by the evaporation of these will cause the objects, especially such as are near the edges of the liquid, to move in all directions, and their true form may be discerned. Sometimes moving the thin glass cover sidewise, the object being kept in view, will answer the same end.

c. In figures of microscopic objects, the side view should always be exhibited or described.

d. In the case of crystalline bodies, or such as present angular edges, their angles should be measured with the goniometer, if their chemical composition be unknown.

2. *The Colour.*—The colour of objects should always be carefully described, and its cause accurately determined. It most commonly arises from:—1, partial absorption; 2, the presence of pigment, or other colouring matter; 3, from iridescence; 4, from polarization, &c.

(1.) The most common cause is a peculiar property by which a portion of the coloured rays composing the white light which falls upon or is transmitted through an object is absorbed, the remainder being reflected or refracted so as to reach the eye. On examining bodies thus coloured, with whatever powers, their substance is found uniformly coloured, and this colour is unchanged by their immersion in water or oil of turpentine, and is the same in transparent bodies by both transmitted and reflected light. This is commonly regarded as the *proper colour* of an object. Example: a crystal of blue vitriol.

(2.) *a.* In many cases, however, although an object may appear to the naked eye uniformly coloured, on examining it with a high power, the colour, which in fact arises from the above cause, is seen to be confined to certain molecules or granules, whilst the general substance is colourless. These granules may consist of vegetable or animal colouring-matters, metallic oxides, &c. The nature of these matters should always be determined, if possible, either by microscopic chemistry—micro-chemical analysis, as it has been called,—or by ordinary chemical analysis. When the colouring-matter is of organic nature, and when its composition cannot be determined, or it has no definite name, it is called *pigment.* Objects coloured by pigment, metallic oxides, or other colouring matters, are best examined by direct (not oblique) transmitted light, and when immersed in either water or oil of turpentine. These liquids do not change the colour, nor destroy it unless the pigment be soluble in them; but by rendering the general substance of the object more transparent, they cause the granules to become more distinct. The colour is the same both by transmitted and reflected light. Example: a brown or black hair of an animal, as the mouse.

b. Sometimes bodies coloured by pigment or other colouring-matters appear under the microscope uniformly dyed, although the colouring-matter consists of an insoluble molecular or granular powder—as a white animal hair first macerated in solution of ferrocyanide of potassium and then in solution of perchloride of iron. Chemical means will alone distinguish this cause of colour from the first, by removing the colouring-matter from the colourless basis.

(3.) The colours of many objects vary according to the direction of the light transmitted through them, or are only visible by oblique light, and the colours are different by direct and oblique light. These arise from decomposition of white light by either interference or refraction. For the sake of brevity, these may be designated *colours from iridescence,* because they mostly exhibit the brilliancy and transparency of the colours of the rainbow. The interference or refraction upon which they depend is ordinarily produced by irregularities of structure, frequently depressions or grooves, and sometimes cavities containing air, &c. Objects exhibiting these colours, which are most brilliant by very oblique light and under low powers, when examined with a moderately high power by transmitted direct or but slightly oblique light, frequently appear more dull and less brilliant, often dark or black in parts; and when immersed in oil of turpentine, or some liquid approaching in refractive power the substance of which they are composed, so that their irregularities become filled with it, the colours vanish. Hence colour, when arising from iridescence, can readily be distinguished from that arising from general absorption

or from the presence of pigment; and when the colour of an object obeys the above law, it may be predicted that structural irregularities sufficient to account for its production will be found if properly sought for. Moreover these colours are not the same by reflected and refracted light, and they vanish under very high powers. They may be studied in the species of *Pleurosigma*; and those observers whose microscopes do not magnify sufficiently, or whose object-glasses have not sufficient angular aperture to admit of the detection of the markings upon some of the Diatomaceæ or other bodies of similar structure, may be sure that they are present when these phenomena have been observed. We were thus led to search for them upon the valves of *Melosira varians* and *Borreri*, species of *Nitzschia*, &c., where they had not been previously detected; and there they are present. Again, the colours of the dried valves of the Diatomaceæ, many of which have a brown tinge, have been supposed to depend upon the presence of the peroxide of iron; but as this colour vanishes when the valves are immersed in oil of turpentine, independently of the fact that the valves do not present the same brown colour by reflected and transmitted light, and by direct and oblique light, which we have stated to be characteristic of the presence of colouring-matter, the colour cannot arise from this cause.

An example of iridescent colour arising from the presence of fibres, is found in the tapetum. Certain cases, referable to this head, require special notice. Thus it sometimes becomes a question whether a very minute red spot, visible in an Infusorium, Alga, &c., is the optical expression of a minute vacuole, or a little depression filled with water, air, or other fluid of less highly refractive power than the substance of which the organism consists, or whether it arises from the presence of pigment. The point is easily decided: a practised eye will recognize the transparency of the colour where not arising from pigment, and its granular appearance where the pigment is present. If the substance of the object be soft, compression will frequently destroy the appearance when pigment is absent. Drying the object and then immersing it in oil of turpentine or other highly refractive liquid will do the same, whilst pigment will become even more distinct if present. Moreover, on altering the focus of the object-glass, the colour will be found to change, when not arising from pigment.

The colours of thin plates are so rare in microscopic objects, that we must refer to works upon optics for an account of them. They occur in the crystals found upon the surface of the scales of various fishes, the eggs and wings of insects, &c.

(4.) The colour arising from polarized light is noticed under ANALYTIC CRYSTALS, DICHROISM, and POLARIZATION.

The colours of objects examined by transmitted light are frequently rendered much darker, and colourless or coloured objects may appear dark or even quite black, from refraction or reflection of the light out of the field of the microscope. Thus powdered vermilion appears almost black; air-bubbles appear black at the margins or entirely black, &c.: hence the importance of comparing observations made by both reflected and transmitted light; for neglect of this precaution caused the air in the hairs of animals to be mistaken for pigment. Milk-white opacity mostly arises from the presence of numerous molecules, granules, thin layers of liquid or other surfaces which reflect a large quantity of the light incident upon them, as in milk—where the reflecting bodies consist of the globules of fatty matter (butter),—white paper, tubercle, &c.

3. *Structure of the Surface.—a.* When an object is of comparatively large size, the

structure of the outer surface is in general easily determined by examining it with reflected light, *i. e.* as an opaque object illuminated by the Lieberkühn or side-condenser; but when the objects are small, sufficient light cannot be thrown upon them with ordinary condensers; recourse must then be had to the opaque reflectors mentioned at p. xxi.

b. The appearances presented must also be controlled by those resulting from the action of transmitted light. And here we meet with a difficult task, in accomplishing which, the following questions are constantly presenting themselves:—Do certain spots, lines, or other markings visible upon the surface represent elevations or depressions? Are they cavities in the outer portion or layer of the object? Are they foramina or holes? Are they granules of pigment, or rows of them? Do the lines represent a true lined structure, or are they optical illusions? Is the surface smooth and free from markings? The methods of answering these questions must vary so greatly, according to the nature of the object, its size, &c., that it would be almost impossible to lay them down by rule. The following considerations, however, are of most importance.

c. In many cases where structural appearances are visible at the surface of an object, their true situation above or beneath the surface may be determined by raising the object-glass above the focus of the surface. On then carefully and gradually depressing the object-glass with the fine movement, the structure first brought into focus is the uppermost. Thus, the inner surface of the under membrame of the elytrum of the stag-beetle (*Lucanus cervus*) is covered with very minute hairs projecting from the surface (Pl. 34. fig. 2). On placing this with the inner side uppermost and adjusting the object-glass as just described, the hairs are distinctly brought into focus before the surface of the membrane. Hence they are situated upon the surface; whereas, had the surface of the membrane been brought into view before the hairs, it must have been concluded that the latter were situated on a plane below this. It may be stated that the surface of a membrane is recognized to be in focus by certain irregular granules, molecules, or wrinkles mostly visible upon it.

d. Frequently, when hairs, filaments, or spines project from a surface, their relative position may be determined by examining the margin of the object if it be rounded, or the margin of a fold if it be flat and membranous—as in the case of ciliated bodies, Infusoria, &c.

e. Cilia upon the surface of an object are sometimes so minute and transparent as to be with difficulty detected; they can however always be made evident, when present, by the following means:—1. Drying the object; they then become much darker from refraction. 2. Dyeing the object with solution of iodine; drying the object after the addition of the latter solution is sometimes advantageous. 3. Mixing insoluble coloured particles, as those of lampblack, or Prussian blue, with the water in which the objects are contained; of course this is only of use if the objects be living; the particles will then be set in motion, and their motion may be distinguished from molecular motion by the definite direction in which the particles move.

f. The nature of many markings, spots, &c. in transparent objects is best determined by Dujardin's method, viz. that of comparing at different foci the effects of the refraction of the transmitted light produced by the markings themselves, and the substances in which they are situated; and these phenomena may be conveniently illustrated by their occurrence in known objects. If a drop of oil of turpentine, which has been digested with alkanet root so as to become coloured, be placed upon a slide, a drop of water added to it, a thin

glass cover applied, and the cover be moved backwards and forwards upon the slide with the finger covered with a cloth, the drop of oil will be subdivided into globules of various sizes, some of which will enclose globules of water; thus we shall have globules of the oil surrounded simply by water, globules of water enclosed in globules of oil, and some of these globules will contain within them globules of the other kind again, the globules of oil being readily distinguished by their red colour. On examining the slide with a tolerably high power, all the globules will appear bounded by a black circle, and present a luminous point in the centre, when viewed separately and the focus suitably adjusted for each. But when they are examined in comparison and together, they will be found to exhibit characteristic appearances according to the variation of the focus. Thus, of the simple globules, when their margin is most distinctly brought into focus, some will become more luminous as the object-glass is depressed (Pl. 49. fig. 1 *a*)—these are globules of water surrounded by oil; others will become darker under the same circumstances (Pl. 49. fig. 1 *b*), and very luminous as the object-glass is raised (Pl. 49. fig. 1 *c*)—these are globules of oil; and the nature of the components of the compound globules may easily be determined by the occurrence of the same phenomena. The globules of oil being more highly refractive than the water, act like little convex lenses; whilst the globules of water surrounded by the oil, exerting a lower refractive power than the latter, act like concave lenses, and their centre appears luminous because the rays which traversed them diverge as they ascend, as if they emanated from a (virtual) focus situated beneath the globules, or on the same side of them as the mirror. Hence these foci may be distinguished as the "lenticular foci" of the objects. And when dots or markings upon objects are very minute, frequently all that can be distinguished under the microscope are these lenticular foci of the various parts.

The same phenomena may be observed in air-bubbles immersed in water; these correspond with the globules of water surrounded by the oil. It need scarcely be remarked that the object in colouring the oil is to allow of the control of the conclusions arrived at.

g. In the globules of sarcode or protoplasm and many cells, the vacuoles are easily shown, by the same method, to be filled with a material of less refractive power than the general substance of which they are composed: these vacuoles are frequently mistaken for nuclei and nucleoli; but they are readily distinguished from them by the dark appearance they present when the object-glass is raised above the focus of their margins.

h. The above principles are applicable to the determination of numerous cases where the elevation or depression of a spot or marking upon a surface is called in question; for elevations on a surface will produce the general effect of convex lenses, whilst depressions will produce that of concave lenses. In the above experiment, plano-convex lenses of both oil and water are frequently seen, and readily distinguished by the above means.

Take also the instance of a *Paramecium aurelia*, either dried or immersed in water. The surface is beautifully marked with pretty regular dots, which appear luminous as the object-glass is depressed (Pl. 32. fig. 1 *a*), and dark as it is elevated (Pl. 32. fig. 1 *b*); hence they consist of depressions upon the surface. Had they been elevations or little tubercles, they would have become more luminous as the object-glass was raised, and *vice versâ*.

When an isolated granule of pigment or of any opaque substance is brought into focus, on raising the object-glass a luminous spot appears to occupy its place; hence it agrees so far with a highly refractive granule. The appearance, however, arises from diffraction,

and may usually be distinguished from that produced by refraction by the luminous spot equalling or exceeding the granule in size, whilst in the latter it is smaller and more brilliant.

i. In all these experiments the less oblique the light the more certain will be the results. But this method is inapplicable to decide whether the less refractive portions are simply depressions or cells. This may often be determined by examining the margin of the object where possible (as in *Paramecium*), and observing whether there are depressions upon it corresponding to the parts at which the dots are situated, and whether these depressions are continuous with the dots (Pl. 32. fig. 1 *b*). When the substance of the object is somewhat firm, drying it, if moist, will cause the dots to become filled with air; they will then, if cells, appear infinitely blacker than if simply depressions, and visible as readily by direct as by oblique light; and after the object has been moistened with water or oil of turpentine, if it be immediately examined, the blackness of the dots will appear still greater, and they will be distinctly visible by direct light; whilst depressions are much more easily filled with liquid, and then, if minute, will only be visible by oblique light.

In relation to this matter, the meaning of the "optical section" of minute objects viewed under the microscope is important to be considered. Taking a globule of oil, or a pollen-grain, and bringing the object-glass to focus upon the upper surface, at first the portion of the surface which is in focus is visible; on lowering the object-glass, the surface becomes invisible or indistinct, while a portion of the margin comes into focus, forming a ring. This enlarges until the most convex portion is reached, when it diminishes until the lower portion of the globule or grain is visible. In this way we obtain the same views of the object, as if so many transverse sections or planes were examined. The better the corrections of the object-glass, and the larger the angular aperture, the more distinctly will these phenomena be developed.

k. If it can be shown that the parts corresponding to the dots are depressed below the general surface, and the dots or depressions present an angular outline, these dots cannot possibly represent cells, because, if the angularity of the outlines of cell structures arose from the pressure of surrounding or adjacent cells, this pressure would necessarily be exerted also upon the free or external portion of each cell, so as to render it convex, or at any rate not concave. The firmness of the substance of the object must be attended to, because, where it is absent, as the cells part with the liquid portion of their contents the outer portion of the cell-wall may become approximated to the inner, and thus no space be left for the air to enter, as in the exuviæ of a *Triton* for instance.

l. In brittle objects, as the siliceous valves of the larger Diatomaceæ, the examination of the margins of crushed and perfectly flat portions is important and sometimes conclusive; for it may be found, as in *Isthmia* (Pl. 17. fig. 2 *b*) &c., that the depression of the object-glass requisite to bring into focus the margins of the thin depressed portion is much greater than that required for the intermediate thicker parts. In the valves of the more delicate Diatomaceæ (*Pleurosigma* &c.), in which this observation is difficult to be made, the point is important that the line of fracture of the broken valve passes through the rows of dark dots or the lines corresponding to them, showing that they are thinner and weaker than the rest of the substance; had these dots represented elevations, the valves would have been stronger at these parts. The nature of the markings upon the siliceous valves of the Diatomaceæ, especially the species of *Pleurosigma*, has long formed a disputed point. In distinguishing in general minute points, as the little siliceous spines of the cuticle of *Equi-*

setum, the very short spines on the wings of many insects (*Tipulidæ* &c.), or the minute spheroids in Schultze's siliceous films, it may aid somewhat to remember that prominences are usually most distinct under open central illumination, while depressions are most evident under the central-stop illumination. If we take a flat fragment of an *Isthmia*, and examine it by the aid of the condenser with a central stop and an object-glass of lower power, care being taken that the condenser and stop are perfectly central, it will exhibit a series of angular dark or black dots bounded by luminous lines separating them (Pl. 15. fig. 47), and this when all parts of the object are best in focus; for when the object-glass is elevated or depressed, the whole becomes indistinct. The black dots in this instance clearly coincide with the depressed portions of the surface of the valve. The same phenomena may be observed in many other Diatomaceæ, as *Triceratium* (Pl. 17. fig. 29), *Coscinodiscus* (Pl. 51. fig. 1), &c. But when we examine those which have very fine markings, as the valves of *Pleurosigma* (Pl. 15), the appearances vary greatly, according to the method of illumination. The dark lines (Pl. 15. figs. 10, 12, and 25), which are brought to view by oblique illumination, correspond to the rows of the black dots of *Isthmia* (the thinner and weaker portions of the valves), and with stop-illumination are resolved into the separate dots (Pl. 15. fig. 40), the rest of the valve appearing white and uniform. But at a different focus, especially under immersion-lenses, the white portions of the valve present the appearance of rows of bright pearls (Pl. 15. fig. 46), the other portions of the valve appearing dark. The same brilliant pearls are seen in the finer valves of *Coscinodiscus* with the open central illumination. The article DIATOMACEÆ must be consulted for further details in regard to the structure of these valves, and the article ANGULAR APERTURE in regard to the changes produced in the appearances of objects by variation of the angular aperture of the object-glass, and of the degrees of obliquity of the transmitted light. But we may remark here that these dots must not be compared to cells, but to the depressions found upon the seeds of the white poppy, *Paramecium*, &c., in which forms resembling those resulting from the mutual pressure of adjacent cells are present, but do not arise, so far as we know, from this cause.

m. No special remarks are required in regard to furrows, as these are only elongated depressions.

n. When ridges are present, these are frequently left projecting at the margin of a fragment; sometimes they project naturally; and it may readily be known that they are thicker portions of structure, by their blacker margins and their exhibiting the characters of elongated convex or plano-convex lenses.

In some cases, the position assumed by confined portions of air, when the object is immersed in liquid, will denote the existence of ridges. Thus we have seen portions of air, accidentally confined between the surface of a scale of *Lepisma saccharina* and the thin glass covering it, assume an elongated form, being limited laterally by the ridges upon the scale (Pl. 34. fig. 3).

o. Foramina or holes are in general readily distinguished by their dark and defined margins, and the absence of colour when they exist in coloured structures; when existing in transparent colourless objects, the latter mostly exhibit minute irregularities, by which the presence of some kind of matter is indicated, whilst these are absent in the foramina. Where there is difficulty in deciding, the structure should be broken, if possible, and the margins examined. Sometimes the polariscope is of use: the general substance may

polarize light; but of course the foramina will not do so. Charring the structure, or colouring it with reagents, if organic, will sometimes afford decisive proof.

Foramina cannot be mistaken for elevations on the surface, because they do not become more luminous as the object-glass is raised after their margin has been brought most distinctly into focus; in fact the reverse occurs: hence they so far agree with depressions; but they differ from these in their luminous appearance with high powers, and their not being rendered more distinct by oblique light, but the reverse.

p. When the structure in which they are situated is somewhat thick, and they form rather tubes than foramina, as the axes of these can hardly coincide with the direction of the transmitted light, their orifices will appear dark or black; hence they might be mistaken for granules of pigment: immersion or maceration of the structure in oil of turpentine, however, will fill them, and cause the dark appearance to vanish, whilst pigment would still be visible. Examination by reflected light will also readily distinguish the one case from the other. Also where this tubular structure is present, perpendicular sections will exhibit furrows, which may be recognized as directed above. In distinguishing foramina, the higher the power employed the less is the difficulty.

q. It has sometimes to be decided whether certain dark lines visible at the surface of objects, represent ridges or grooves, or whether they are illusory shadows arising from the passage of light through a structure furnished with depressions, granules of pigment, &c. This must be done by examining the object when illuminated by reflected light, or a hollow cone of oblique rays, such as is obtained on using the achromatic condenser with the central stop; when thus illuminated, the lined appearance will vanish, and the true structure will become visible.

r. It often happens that objects, especially highly refractive bodies, appear surrounded or covered by a number of black lines, rings or annular lines, arising from diffraction, and it becomes an important question whether these lines represent cell-walls, rows of dots, &c. When they arise from diffraction, they vary in number according to the obliquity of the incident light and the angular aperture of the object-glass; and when the condenser is used, they vary according to its adjustment, and at a particular adjustment they will sometimes disappear entirely. Hence in these cases the condenser should always be used, and the results obtained controlled by the effects of immersion in highly-refractive liquids, and the means mentioned below.

s. A very ingenious method has been proposed and adopted successfully by Wenham, for exhibiting the form of certain very minute markings upon objects. A negative photographic impression of the object is first taken on collodion in the ordinary way, with the highest power of the microscope that can be used. After this has been properly fixed, it is placed in the sliding frame of an ordinary camera, and the frame-end of the latter adjusted into an opening cut in the shutter of a perfectly dark room. Parallel rays of sun-light are then thrown through the picture by means of a flat piece of looking-glass fixed outside the shutter in such a manner as to catch and reflect the rays through the camera. A screen standing in the room, opposite the lens of the camera, will now receive an image, exactly as from a magic lantern, and the size of the image will be proportionate to the distance. On this screen is placed a sheet of photogenic paper intended to receive the magnified picture. A portion of the valve of a *Pleurosigma* magnified in this manner is represented in Pl. 15. fig. 41.

4. *Internal Structure.*—We must be understood here as referring to the general structure

of an object, *i. e.* whether it is solid or cellular, &c.; and where an object is composed of an aggregation of similar parts, our remarks must be applied to these individually.

The first question arising is whether a transparent object is solid or semisolid and homogeneous, or whether it represents a cell, *i. e.* has an outer membrane or cell-wall and contents of a different nature. When objects possess an outer coat, its two margins are sometimes easily distinguishable on examination by transmitted light, especially when its thickness is considerable. But when the outer coat is thin, these are difficult to distinguish; recourse must then be had to other means than simple inspection; and these will vary according to the nature of the object, and especially the softness of its cell-wall. Sometimes crushing it may show clearly that the contents consist of a liquid with numerous molecules and granules, and that the cell-wall is thin and membranous; for the subsequent addition of water may separate and render both distinct. The most valuable test-method, however, is the production of endosmosis or exosmosis. If we take a cell with a soft and thin wall, and add distilled water to it, it will imbibe a certain quantity of it and become distended, and often the contents will become distinctly separated and visible within; whilst if a saturated solution of some salt, as chloride of calcium, be added, it will become wrinkled and collapsed. On treating a solid or homogeneous body with water, it remains unaltered, or perhaps swells slightly; but on treating it with the solution of chloride of calcium, no wrinkling or contraction occurs, and its appearance is unchanged. If the outer coat be firm and resisting, the chloride will not cause it to contract and wrinkle.

If there be two coats, the outer being firmer than the inner, the latter will be wrinkled and collapsed, while the former retains its shape; this is the ordinary occurrence in young vegetable cells. The exosmotic effects of the chloride of calcium should be looked for soon after its addition to the object, particular care being taken that it comes into contact with the object; for when solid or semisolid bodies are macerated for a long time in the saline solution, they will become contracted, and globules of sarcode will escape from them; but we believe that in all these cases there really exists a cell-wall, or a structure corresponding to it; hence by solid or semisolid bodies, we must be understood to mean those which differ from cells according to the characteristic action of exosmose.

It must be remembered that solution of chloride of calcium is a highly refractive liquid; hence it frequently renders globules so transparent that they are almost or completely invisible, and thus apparently dissolves them; sometimes also it really dissolves them. Moreover many so-called unicellular vegetable organisms exhibit the contraction of the internal cell-wall or primordial utricle, from long maceration in water only, as is so frequently seen in the Desmidiaceæ "mounted" in water. An aqueous solution of iodine is also frequently useful in bringing to light the existence of an inner cell-wall, especially in vegetable structures, causing it to become wrinkled and collapsed.

Cells have not the tendency to fuse together or adhere to each other, which globules of sarcode or other glutinous solid or semisolid substances have.

If the object be brittle, crushing it will sometimes show its internal structure, by allowing the examination of the margins of the fragments.

Spherical or rounded solid bodies, when immersed in water or other liquids of low refractive power, generally present a much less distinct black margin than cellular bodies, or those with membranous walls.

The determination of the contents of an object furnished with an outer coat, must be made according to the foregoing indications. The contents often consist of liquid in which

are suspended molecules and granules. If these exhibit molecular motion, the material in which they are suspended must be liquid. It sometimes becomes a question whether a body enclosed within another is central or lateral. This is readily determined by causing the body to revolve by inclining the stage of the microscope, when, if central and fixed, the enclosed body will retain this position; and if it be less than the cavity of the enclosing structure, positive indication will be afforded that the latter is solid, or at least that it does not consist simply of an outer coat with liquid contents and the enclosed body. But if it be attached to the inner wall of the enclosing structure, the eccentricity of its motion whilst revolving will be evident.

The contents of microscopic bodies are frequently rendered distinct by the addition of reagents, and in some cases can only be distinguished by their use; thus the nuclei of animal cells are at once made evident by the addition of acetic acid, &c.

The micro-spectroscope is often used in detecting small quantities of different substances (SPECTROSCOPE).

We frequently have to decide whether the interior of an object is solid or tubular. If it consist of a firm substance, drying it, if in liquid, will cause the evaporation of the liquid or other contents, and the entrance of air. A section of it will also show whether it is solid or hollow. The effects of crushing it should also be observed.

An important aid in describing the structure of many objects, the components of which are of so nearly similar refractive power as to be undistinguishable by any variation in illumination, is that of dyeing or staining. Different portions of a structure often have a variable affinity for colouring-matters or dyes, and can thus be readily distinguished. The various appropriate dyes are mentioned under the tissues, and the process under STAINING.

B. HISTOLOGICAL ANALYSIS.

This consists in the resolution of the object into its component morphological elements, and is usually effected by subjecting it to the action of various chemical reagents, continued maceration, &c. It must never be attempted if inorganic matters be present in quantity, until these have been previously removed. The reagent used should be one which exerts a solvent action upon the substance of which the object is composed, the action being interrupted at a certain stage by the addition of water, &c. In regard to those objects whose morphological elements have become altered by individual growth, &c., histological analysis is of course useless, and the manner in which these have acquired their existing structure can only be determined by tracing the gradual changes which their morphological constituents undergo, from the earliest period of their existence to that at which they form the object in question. This constitutes the study of development; or it might be termed Histological synthesis. It can rarely be followed directly, but may often be carried out indirectly by examining a number of the objects in all stages of their development, and comparing the changes undergone by their constituents. It requires special care in controlling the identity of the objects.

C. CHEMICAL REACTIONS.

We cannot too strongly insist upon the necessity of investigating these in the case of all objects submitted to examination, the nature of which is at all doubtful—and this because in many instances the form or general appearance will afford no criterion by which the nature may be determined. Judgment founded simply upon the form, or upon the

mere inspection of an object, therefore, will illustrate the abuse and not the proper use of the microscope. The quantitative and ultimate analysis of substances cannot be made in any manner by the aid of microscopic manipulation; but the qualitative analysis, or the study of the action of chemical reagents upon the object or substance by the aid of the microscope, or micro-chemical analysis, may be undertaken with the prospect of almost certain success, in most cases at least, in ascertaining the proximate chemical composition.

The characteristic reactions or tests for the various proximate principles are given in this work under the respective heads of those substances; and we can here give only a brief sketch of the manner in which the micro-chemical analysis of a substance may be conducted, and without which its microscopic investigation must be imperfect and of little or no value.

The first point to be attended to is, to ensure, as far as possible, the freedom of the object from foreign admixtures. Thus, if it should have been found in an animal or vegetable liquid, it must be carefully washed, either in a watch-glass or upon a slide whilst covered with thin glass. The former is readily accomplished: the substance being placed in a watch-glass, water or other solvent of foreign matters is added; the whole is then set aside, to allow of the subsidence of the substance, and the supernatant liquid removed by a pipette. If the body or the particles be very minute, it or they must be placed upon a glass slide, and covered with thin glass; the latter should then be pressed, so far as is possible without crushing the particles, but sufficiently to fix them, and a small piece of coarse white blotting-paper placed upon the surface of the slide, so as to touch the edge of the liquid; capillary attraction will cause the liquid to be absorbed by the paper. Small quantities of water, or other proper solvent, are then added by small portions from the end of a glass rod to the *opposite* edge of the liquid confined by the thin glass. Thus a current will be set up, and the newly added liquid will be absorbed by the blotting-paper, washing in its course the particles confined between the two glasses. The current will be regulated by the quantity of liquid added, and the facility with which the paper absorbs it.

When the body has been washed, the effects of the various reagents may be examined, by the addition of them in small quantities from the conical stoppers of the test-bottles (see *Test-box*, p. xxvii). The test-liquid being applied to the edge of the liquid in which the body is immersed, gradually mixes with it, and the effects produced may be watched step by step. If a solvent or other action is seen to take place, the result is decisive; but if no action be evident, it must be remembered that the reagent added may not have reached the object under examination, perhaps from an insufficient lapse of time for the occurrence of diffusion in the two liquids. To be positive, therefore, that the reagent has no action upon the object when none is at first apparent, as much as possible of the liquid in which it is immersed should be removed by blotting-paper; or the liquid be gently driven off by evaporation; or, if the object be of sufficient size to ensure its not being lost, the thin glass should be removed, and the whole, or as much as possible, of the liquid removed either by the blotting-paper or evaporation. On then covering the object with the thin glass, and adding the reagent to the edge of the latter, there can be no doubt of its coming into contact with the body; and the result may be considered decisive.

Where the combined effects of a reagent and heat are required to be observed, the former may be added as usual, and the slide placed upon the brass table mentioned at p. xxviii

until the liquid boils, or the requisite amount of heat has been applied,—the object of course being covered by thin glass. The slide must then be allowed to become perfectly cold before being placed under the microscope; otherwise the heat might melt the balsam with which the lenses of the object-glass are cemented together. The cooling is much facilitated by placing the slide upon a plate or surface of metal; we generally use the foot, or a part of the stand, of the microscope for this purpose.

The effect of a red heat is sometimes very desirable to be tested. This may be accomplished by exposing the object, placed upon a strip of platinum foil, a piece of thin glass or of mica, to the flame of a spirit-lamp. The odour evolved should be noticed. If this be ammoniacal, or resemble that of burnt horn, the body, if not crystalline, is probably of animal nature, and certainly contains nitrogen.

If the body consist solely of inorganic matter, or of oxalates, it will not be blackened by the heat. If it consist partly of inorganic and partly of organic matter, it will be blackened, and the inorganic matter will be left in the form of an ash. The alteration produced in the form of the object by the heat should also be noted.

In applying a red heat to a substance upon thin glass, the whole of its moisture must first be expelled by evaporation; otherwise the glass will certainly crack, and the experiment be spoiled. The strip of platinum may be held by forceps; and the thin glass or mica, upon a curved piece of iron wire. We can here add only a few of the reagents the action of which it may be most desirable to obtain in determining the nature of a doubtful body. Further particulars will be given under the heads of the various reagents, principles, and tissues, in the body of the work.

1. *Solution of caustic potash* (especially when heated).—The cell-walls of plants are not greatly affected; they retain their primitive form, only becoming somewhat swollen, whilst animal substances are mostly dissolved; chitine, however, is unaltered. The solution also possesses a remarkable power of separating many animal structures into their component cells, &c. When cold, it separates proteine compounds from fatty matters, &c. It also removes the foreign compounds with which the cellulose of the epidermal structures of plants is often imbued. Its action has been proposed to distinguish an animal from a vegetable organism, and will yet probably prove to be of value in this respect.

2. *Solution of iodine* (in water) dyes most animal and vegetable substances brown; renders also lime brown; colours starch, certain cell-walls of vegetables, amyloid, the amylaceous bodies of the human brain, &c. blue.

3. *Sulphuric acid*, when added to the external coat or cell-wall of plants (cellulose) dyed with iodine, renders it blue or purple (Pl. 7. figs. 1 *c* and 3 *c*). In a few instances, however, where cellulose exists in animal tissues, the same blue colour is produced; but in these there is real animal matter also, recognizable by its appropriate tests. When added to bile or proteine compounds mixed with solution of sugar, it renders them red (Pettenkofer's test). If the body contain lime (except already as sulphate), the acicular crystals of the sulphate (Pl. 10. fig. 16) are produced.

4. *Muriatic acid* with heat colours the proteine compounds.

5. *Acetic acid* brings into view the nuclei of animal cells and tissues, dissolves many salts, &c.

6. *Dilute nitric acid* (20 per cent.) coagulates albumen, renders unstriped muscular fibre-cells very distinct, &c. Strong acid by boiling removes all but the cellulose from woody fibre.

7. *Millon's test-liquid* for proteine compounds. (See MILLON'S TEST.)

8. *Ether* or *benzole* dissolves fatty and resinous matters, &c.

9. *Chromo-sulphuric acid*, or a mixture of solution of bichromate of potash and excess of sulphuric acid, dissolves the intercellular substance of plants, thus isolating beautifully the wood-cells &c., and developes the starch-rings &c.

10. *Ammoniuret of copper*, formed by digesting copper turnings in an open bottle with solution of ammonia, rapidly dissolves cellulose. It must be used fresh.

11. *Dye-tests.*—Carmine and ammonia, or the aniline-compounds, Judson's dyes, magenta, picro-carmine, logwood, chloride of gold, picric acid, &c. are often used as such (STAINING).

These are perhaps the most common reagents which the experimenter will be called upon to use. A general plan for the qualitative analysis of substances must be obtained from works upon chemical analysis. It may be remarked, however, that the qualitative analysis of portions of a substance too minute to be more than barely discerned by the naked eye, may be effected by the aid of the microscope. The use of the microscope in strictly chemical investigations also, cannot be too highly recommended; for it will frequently throw great light upon the distinction of chemical precipitates of closely approximative chemical properties.

D. MEASUREMENT.

A knowledge of the size of objects is of the utmost importance, and is frequently of great assistance in the distinction of one object from another; for many objects of totally dissimilar nature present exactly or nearly the same appearances when examined with different powers. The dimensions should invariably be added to the description of microscopic bodies; and when figures are given, the number expressing the linear amplification of the objects should be placed near them.

Directions for determining the measurement of objects are given under the head MEASUREMENT. It should always be expressed in fractions of an English inch.

In conclusion, we must remark that the observations given in this Introduction are not offered as by any means complete. However, we trust they will serve to show that there are numerous means at command for determining the structure of objects, to indicate the nature of these means, and that microscopic researches should be carried out upon something like a definite plan.

MICROSCOPIC ANALYSIS.

The following list of miscellaneous matters, forming an analysis of the second part of the Introduction, may serve to recall to the observer the most important points to be looked for, and the means of discovering them.

MICROSCOPIC ANALYSIS. Form :—*a, outline*; *b, rolling over*; *c, side view*; *d, end view*; *e*, angles, *goniometer*.

Colour:—1, General colour, true colour; 2, pigment; *a*, partial from pigment; *b*, general colour from pigment; 3, iridescence, thin plates; air-bubbles, &c., *immersion in highly refractive liquids, action of transmitted and reflected light*; *compression*; polarization, &c.

Surface:—*Reflected light*; projections; cilia, *margin, iodine, desiccation, fine particles*; hairs, crystals—upon or beneath the surface; tubercles, ridges, folds, *side view*; *effects of altered focus*; *fracture*; *foramina, polariscope*; illusory lines, diffraction; depressions, circular, angular; furrows; tubules; cells; *oblique light, stops in condenser.*

Internal structure and contents:—Homogeneous; cell-wall, *endosmosis, exosmosis, chloride of calcium*; *adherence*; *margin, crushing, molecular motion*; granules, nucleus—central, excentric; *reagents, acetic acid*; *nucleolus*, vacuoles.

HISTOLOGICAL ANALYSIS.—*Reagents*; *maceration, development.*

MICRO-CHEMICAL ANALYSIS.—*Washing*; *heat*; *red heat, odour, ash*; *reagents, contact with reagents*; *potash, ammoniuret of copper, iodine, sulphuric, chromo-sulphuric, muriatic, nitric, acetic acids*; *Millon's test*; *sulphuric acid and syrup*; *sulphuric acid and iodine*; *ether or benzole, &c.*; *dyes.*

MEASUREMENT.—In fractions of an English inch (not line nor foreign measures).

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MICROGRAPHIC DICTIONARY.

ABERRATION.—The deviation of the rays of light from the true focus of a lens or curved mirror, in consequence of which they do not unite at a single point, but form an indistinct or coloured image of an object. It arises from two causes: the form of the lens or mirror, when it is called spherical aberration; and the different refrangibility of the rays of light, when it is called chromatic aberration.

ABROTHAL'LUS, Notaris and Tulasne. —A genus of Lichens, Fam. Lichenacei, remarkable for their parasitic habit and the absence of a thallus. The species are now referred to LECIDEA.

A. Smithii (Welwitschii and microspermus) = *L. parmeliarum.*

A. oxysporus = *L. oxysporus.*

A. inquinans = *L. inquinans.*

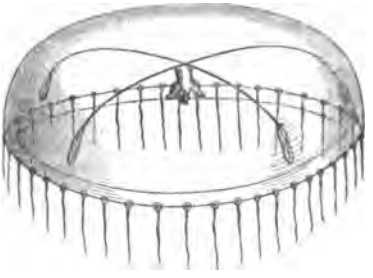
BIBLIOGRAPHY. Lindsay, *Brit. Lich.* 311; Tulasne, *Ann. Sc. Nat.*, Bot. xvii. p. 112, 1852; De Notaris, *Mem. R. Acad. Sc. Turin*, x. p. 351, 1859; Berkeley, *Cryp. Bot.* 405; Leighton, *Lichen-Flora*, p. 384, 1879.

ACALE'PHÆ (Medusæ).—An order of Cœlenterata, commonly known as Sea-nettles, on account of their producing urtication when touched; or Jelly-fishes, or Sea-blubbers, from their gelatinous consistence.

They consist of a transparent, floating and free, discoid or spheroid body (hydrosoma), often shaped like an umbrella; and vary in size from a mere speck to a yard in diameter. Margin of the disk furnished with filiform tentacles, cirri, &c. The organs are radiate around a longitudinal axis, occupied by a central peduncle or stalk (manubrium), at the bottom of which is the mouth. The disposition of the parts is generally quaternary.

The *cutaneous surface* of the body, or ectoderm, is covered with a very delicate epidermis (Pl. 49. fig. 2). Cilia exist on various parts of the body, especially the

Fig. 1.



Thaumantias hemisphærica, magnified 2 diameters.

arms, tentacles, cirri, &c; upon which also peculiar stinging organs and organs of adhesion occur. In those species which are notorious for their urticating powers, these organs are also situated in aggregations beneath the epidermis of the body. The stinging organs, or nematocysts, usually form oval capsules, in which a spirally coiled filament is enclosed (Pl. 49. fig. 3 *a*, *b*); this flies out on the slightest touch, with the capsule to which it is attached, from the irritated part of the skin (Pl. 49. fig. 3 *c*). In some Acalephæ these stinging organs are replaced by oval capsules from which a rigid bristle projects (Pl. 49. fig. 4). These do not produce urtication, but enable the animal to adhere to other bodies. Near the surface of the body and between the cells composing its substance, pigment-cells frequently occur, some of which are isolated,

others aggregated into groups. The paler and more delicate colours are said to arise in some instances from pigment uniformly dissolved in the substance of the body; it is most probable, however, that they arise from iridescence.

Muscular system forming long, thin, reticular fibres and bundles, almost everywhere pervading the contractile substance of the body.

The floating and locomotion of these animals are often aided by larger or smaller cavities filled with air.

The *nervous system* consists of a ring following the margin of the disk, with ganglionic expansions at intervals, giving off branches to the tentacles and the radial canals.

The *organs of sense* consist of tubercular or spathulate bodies situated near the margin of the body or at the base of the tentacles, and connected with adjoining ganglia. Some of these are regarded as organs of vision (ocelli); and consist essentially of a membranous capsule containing a clear liquid with crystals of carbonate of lime, and sometimes a red or black pigment (Pl. 49. fig. 5 *g*). Those which contain no pigment have been considered to be of auditory function, and the crystalline bodies otolithes. Some of them are protected by an overhanging fold of membrane; hence the distinction of covered- and naked- eyed *Medusæ*; but the latter are now regarded as the sexual zooids or gonophores of the Hydroida (THAUMANTIAS).

The *digestive cavity*, which is situated in the middle of the body, is lined with ciliated epithelium and furnished with distinct walls (endoderm), which are directly continuous with the general parenchyma of the body, so that there is no abdominal cavity. The mouth is either single and central, or multiple. In the former case, it is situated at the end of the peduncle, in the middle of the under side, and leads into a stomach, which is frequently furnished with cæcal appendages. When several oral apertures are present, either several œsophageal canals conduct the nutriment through the arms, in which the oral apertures are placed, to a central stomach, or each separate mouth is connected with a distinct tubular stomach. A distinct hepatic organ has not yet been found. Ray Lankester describes the inception of natural food-materials in the cells of the endoderm.

Gastrovascular system. A number of vessel-like canals run from the stomach or central cavity throughout the body, the principal branches forming rays from the centre to the margin, communicating finally with a circular vessel traversing its circumference (Pl. 49. fig. 5 *d*). These are also lined with cilia, and contain both the food and water. But there is no regular circulation.

The Acalephæ are propagated by the formation of ova, and according to the plan of alternation of generations. They are either hermaphrodite or unisexual.

The reproductive organs of the two sexes are often so similar in colour, external form, and arrangement, that they might easily be mistaken for each other, without examination of their contents. They form either utricular or strap-shaped stripes, placed at various parts of the body, often near the rays of the gastrovascular system. In the former case, the spermatic fluid and the ova are evacuated through distinct excretory ducts; in the latter, the spermatozoa and ova escaping from the strap-shaped testis or ovary, pass directly outwards, or into capacious cavities opening externally by wide orifices. The ova are round, and surrounded by a single very delicate capsule; and the germinal vesicle with its simple germinal spot is visible through the whitish, violet, or yellow yolks. The spermatozoa move rapidly in, and are unaffected by water; they are linear, or one end is rounded, the other prolonged into a capillary appendage (Pl. 49. fig. 5*).

The developmental metamorphosis of some of the Acalephæ is very remarkable. When the ordinary process of segmentation of the entire yolk is completed, the ova become converted into ovate infusoria-like embryos or planulæ (Pl. 49. fig. 6), which revolve upon their longitudinal axis by means of ciliated epidermis, and swim about like species of *Leucophrys* or *Bursaria*. After a time, they become fixed at the anterior extremity to some body; arms then shoot out from the unattached extremity, between which the mouth of the polype-like animal (Hydra-tuba state) is developed (Pl. 49. figs. 7 & 8). At this stage of development, the larvæ multiply by the formation of gemmæ (Pl. 49. fig. 9 *a*), and offsets or stolons (Pl. 49. fig. 9 *b*); and ultimately each undergoes transverse division, which takes place as follows:—the larvæ grow in length, and the body becomes constricted into several segments

(Pl. 49. fig. 10), from each of which eight bipartite processes shoot out in a whorl (Strobila-state). The segments of the body then separate from each other seriatim, from before backwards, swim about with eight rays (Pl. 49. fig. 11), and at last become gradually developed into perfect Medusæ. Many of the Medusæ are phosphorescent, and render the sea luminous.

Gegenbaur divided a *Thaumantias* into a hundred pieces, and found that each piece, provided it contained a portion of the margin of the umbrella, grew into a perfect small *Medusa*.

Many of the organisms formerly considered *Medusæ* are now regarded as the Medusoid buds or gonozoids of the Hydroida. See THAUMANTIAS.

A small *Medusa*, with 2 names: *Craspedacustes Sowerbyi* and *Limnocodium Victoria*, has been found in the tropical fresh-water lily-tank at the London Royal Botanic Gardens. This ought to be the Medusoid gonophore of a hydroid zoophyte!

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ACANTHA'CEÆ.—The seeds of many genera of this family are clothed with hairs composed of hygroscopic cells, containing unrollable spiral fibres or detached rings. Among these are *Acanthodium spicatum*, Delile, *Blepharis*, and *Ruellia formosa*. Other species and genera have the hygroscopic cells destitute of internal fibre, as *Ruellia littoralis, Phaylopsis glutinosa, Barleria noctiflora, Lepidagathis, &c.* Further particulars respecting the hygroscopic cells will be found under CELL-MEMBRANE and SPIRAL STRUCTURES. See also ACANTHODIUM and RUELLIA, and, for a similar phenomenon in other families, COLLOMIA, COBÆA, SALVIA.

BIBL. Kippist, *Linn. Trans.* xix. p. 65.

ACANTHOCYSTIS, Carter.—A genus of Rhizopoda, apparently referable to the Actinophryina.

Char. Rounded, green, with moveable radiating spines and pseudopodia. Body flexible, covered with minute fusiform curved spicula; spines straight, hollow, bifid, discoid at base.

A. turfacea (Pl. 51. fig. 9). Found in heath-bog water; diam. of body $\frac{1}{111}''$.

BIBL. Carter, *Ann. N. Hist.* 1863, xii. p. 263; Hertwig, *Jen. Zeitsch.* (*Qu. Mic. Jn.* 1878, xviii. p. 205).

ACANTHO'DIUM (Flowering Plants, fam. *Acanthaceæ*).—Kippist first described the curious hairs upon the seed of *Acanthodium spicatum*, Delile (Pl. 28. fig. 24). The entire surface of the seed is clothed with hairs of whitish colour, appressed and closely adherent in the dry state, being apparently glued together at their extremities. When placed in water, the hairs are set free and spread out on all sides; they are then seen to consist of clusters of from five to twenty spiral cells firmly coherent below, but free above and separating from the cluster at different heights, expanding in all directions like plumes, and forming a very beautiful microscopic object. The free portions of the cells elongate so as to separate the coils of one, two, or occasionally three internal spiral fibres, which are sometimes branched and not unfrequently broken up into rings; at the lower part of the cells the turns of the spiral are connected by perpendicular processes so as to convert the spiral into a reticulated structure. See SPIRAL STRUCTURES.

BIBL. *Linn. Trans.* xix. p. 65.

ACANTHOME'TRA, Müll.—A genus of ACANTHOMETRINA.

ACANTHOMETRI'NA.—A family of Radiolarian Rhizopoda.

Char. Body minute, spherical, capsular; traversed by numerous elongate, mostly angular and hollow siliceous spines, which meet in the centre. Between the spines, pseudopodia radiate from the body (Pl. 51. fig. 10), as in *Actinophrys*. Marine.

The body contains yellow globules, and is sometimes covered with small spicules; and it is enveloped by a softer cortical sarcodic mass.

The Acanthometrina, with the Polycystina, have been rearranged by Häckel, in his splendidly illustrated monograph, into 68 genera and 150 species.

They are found recent on the surface and at the bottom of the sea, in the Mediterranean, the Adriatic, and the North Sea.

They form beautiful microscopic objects. See RADIOLARIA.

Bibl. Müller, *Ber. d. Berl. Ak.* 1855, p. 248; id. *Abh. d. Berl. Ak.* 1858, p. 1; Häckel, *Radiolar.*, 1862; Claparède and Lachmann, *Infus.* p. 59.

ACAN'THOPUS, Vernet.—A genus of Entomostraca, Ord. Ostracoda, fam. Cytheridæ. Lake of Geneva.

Bibl. *Bibl. Univ.* 1877 (*Jn. Mic. Soc.* 1878, p. 80).

ACA'RÆA.—A family of Arachnida, belonging to the order *Acarina* (Arachnida).

These animals are commonly called mites; and every one is familiar with them as occurring in cheese, sugar, flour, &c. Some also occur upon the skin of man and animals, producing the itch and the mange.

The parts of the mouth and the legs, upon which the characters are usually founded, may be best made out by crushing the animal upon a slide with a thin glass cover, and washing away the exuding substance with water, as directed in the Article Preparation; sometimes hot solution of potash is requisite, with the subsequent addition of acetic acid and further washing. When afterwards dried and immersed in Canada balsam, the various parts become beautifully distinct, and may be permanently preserved.

Acarus (*Tyroglyphus*). Body with a transverse furrow between the 2nd and 3rd pairs of legs; legs nearly equal, all perfect, and terminated by a membranous sucker or claws, or both; palpi adherent to the labium (or lip).

Hypoderas. Body very long, legs very short, and the 2 anterior and posterior pairs far apart; parasitic beneath the skins of birds.

Hypopus. Front pair of legs mostly largely developed; posterior almost atrophied. Parasitic on animals and plants.

Trichodactylus. Rostrum (beak) short, with minute bristles; 4th pair of legs longer than the rest, without claws, and terminated by a very long bristle, the rest with 2 claws. (Parasitic on Bees.)

Psoroptes. Body soft, depressed, spiny beneath and at the base of the legs; posterior pair of legs small and rudimentary, the rest with a claw and sucker; body terminated by two bristly projections. (Parasitic on the Horse.)

Sarcoptes. Body soft, transversely wrinkled, and with dorsal papillæ; anterior 2 pairs of legs with suckers, posterior terminated by a long bristle, and without suckers. (Parasitic.)

Demodex. Body elongate; cephalothorax distinct from the ringed abdomen; legs terminated by 4 or 5 very minute claws.

ACAREL'LA, Kent.—A genus of Infusoria; near *Halteria.* Kent, *Man. Inf.* 1880, p. 214.

ACAREL'LUS, Westwood.—A supposed genus of Acarina. See Hypopus and Phytoptida.

They seem to consist of larvæ of *Phytopti* or species of *Hypopus.*

Bibl. Westwood, *Proc. Entom. Soc.* 1864, p. 30, and 1870, p. 30; Tatem, *Mon. Mic. Jn.* 1872, viii. p. 263; Murray, *Econ. Entomol.* p. 246; McIntire, *M. Mic. Jn.* 1874, xi. p. 1.

ACARI'NA.—An order of Arachnida.

AC'ARUS, Linn. (*Tyroglyphus*). — A genus of Arachnida, of the Order Acarina, and family Acarea (see Arachnida and Acarea).

The palpi adherent to the labium, the perfect legs, and the transverse furrow distinguish the genus.

Ac. domesticus, or *siro* (Pl. 6. fig. 1), the common Cheese-mite. Body oval, soft, whitish, turgid and furnished with long feathery hairs (*b*). The transverse furrow (*c*) occurs at about the anterior fourth of the body; and another is seen between the head and the part corresponding to the thorax. The head is susceptible of elevation and depression. In its natural state it appears conical (*d*), and is furnished with two large mandibles; these consist of a soft retractile basal joint (*e*), and a second, dilated, non-retractile joint (*f*) resembling the fixed claw of a lobster, and a moveable piece (*f**) working against the latter. The last two pieces are toothed where in contact with each other. These mandibles can be advanced separately or together, and be separated or approximated. When in a state of repose, they form as it were a roof above the labium. The labium (*g*) is quadrilateral, elongated, notched at the end, thin anteriorly and in the middle, and consolidated laterally with the palpi, which are 4- or 5-jointed (*h h*). The legs are reddish, inserted in two separate groups, but not very far distant as in *Sarcoptes.* The anterior pair of legs are remarkable for their size in the male, which is smaller and more active than the female; the third pair are the shortest and smallest; the third joint or femur is larger and longer than those next it; the sixth joint is long and thin; the

seventh joint is furnished with a cordiform membranous caruncle, and a single simple claw or hook; rostrum and legs reddish.

This species is viviparous and oviparous, and the eggs very numerous. The larvæ are hexapod.

These mites are very abundant upon old cheese, the powder of which entirely consists of them, with their eggs and excrement.

Ac. longior. Body and hairs longer. Found upon Gruyère and Dutch cheese (Pl. 6. fig. 2). This is the so-called *Ac. Crossii.*

Ac. Siculus. With short legs. Found in powdered Cantharides. Mégnin, p. 143; Murray, p. 274.

Ac. mycophagus. Body long. Found on mushrooms. Mégnin, p. 143.

Ac. entomophagus. Found in collections of insects, of which it devours the body. Mégnin, p. 143; Murray, p. 263.

Ac. malus. On apple-trees in N. America. Murray, p. 275.

Ac. translucens. On coffee-plants in Ceylon. Murray, p. 275.

Ac. bicaudatus. Abdomen furnished with two pediform tubercles, beneath the base of each of which is a stigma. Found upon the feathers of an ostrich.

Ac. fari'næ, same as *A. domesticus.* Found in bad flour. DeGeer, *Mém.* vii. p. 97, pl. 15. fig. 15. (*Ac. feculæ*, found by myriads in potatoes. Guérin-Méneville, *Ann. N. Hist.* 1867, xix. p. 71.)

Rhizoglyphus (Claparède). Tarsi with claws, but no suckers. Vegetable feeders.

R. echinopus. In the bulbs of hyacinths. Murray, p. 257, fig.; Mégnin, p. 144, fig. 49.

R. phylloxeræ. On vine-roots. Murray, p. 258.

R. Robinii. On potatoes, dahlia, and hyacinths. Murray, p. 259.

R. rostroserratus. On decaying mushrooms. Murray, p. 260.

Serrator (Mégnin). Mandibles strongly serrate; a hook, but no caruncle.

S. amphibius. In decomposing mushrooms. Mégnin, p. 144, fig. 50.

Ac. Dysenteriæ. Nyander, *Amœnit. Acad.* v. p. 97; Linn. Gmel. p. 2929. Found in the dejections of dysentery; also in old casks.

Ac. passerinus. Found upon young birds. DeGeer, vol. vii. 139. *Ac. chelopus*, Herm. *Mém. Aptérol.* p. 82, pl. 3. fig. 7.

Ac. (*Carpoglyphus*) *passularum.* With two very long buccal bristles; lives upon dried figs, and other saccharine fruits. Hering, *Nova Acta*, xviii. p. 618, pl. 45. f. 14, 15; Mégnin, p. 141.

Glyciphagus (Hering). Body soft, not divided into two parts by a transverse line or furrow, but with a dorsal depression, and an anal projection; legs perfect, with acetabula; hairs feathery.

A. (*Gl.*) *prunorum.* Found on dried plums; produces the grocer's itch. Hering, *Nova Acta*, xviii. p. 619. pl. 45. f. 16, 17; Murray, p. 278, fig.

A. (*Gl.*) *hippopodos.* Body as broad as long, very acute anteriorly, entirely covered with short hairs; a minute projection at the end of the abdomen. On ulcers of horses' feet. Hering, *Nov. Act.* xviii. p. 607; Murray, p. 279, fig. An undescribed Acarus has also been mentioned as occurring upon the feet of sheep affected with the canker. Grognier, *Zool. vétér.* p. 233.

A. (*Gl.*) *hericius.* Found on weeping ulcers of elms. Robin, *Journ. d. l'Anat.* 1868, p. 603.

A. (*Gl.*) *cursor.* Found in the feathers of the owl and in the cavities of the bones of skeletons. The hairs are jointed. Gervais, *Ann. Sc. Nat.* 2 sér. xv. p. 18, pl. 2. f. 5 *a*; Murray, p. 278, fig.

A. (*Gl.*) *spinipes.* Like *G. cursor*, but smaller; the anal appendage short. Frem. & Rob. *Jn. Anat.* 1867; Murray, p. 281, fig.

A. (*Gl.*) *balænarum.* On whales. Murray, p. 282, fig.

G. plumiger. With strongly feathery hairs. In cellar-dust, stables, &c. Murray, p. 283, fig. A beautiful object.

G. palmifer. Smaller than the cheese mite; hairs leaf-like; body granular. Murray, p. 284, figs. Found with the last.

A. (*Gl.*) (*Sarcoptes*) *palumbinus.* On the pigeon. Koch, *l. c.* fasc. 5. pl. 12; Robertson, *Qu. Micr. Jn.* 1866, p. 201.

Some other species have been insufficiently examined:—

Ac. avicularum, DeGeer, *Mém.* vii. 106. pl. 6. fig. 9. Louse of the grouse. Lyonet, *Mém. Mus.* xviii. 281. pl. 15. f. 16.

Ac. marilæ, Gervais, *Dict. Sc. Nat. Suppl.* i. 45.

Ac. favorum. Found in old honeycombs. Herm. *Mém. Aptérol.* p. 86.

Ac. fungi, Herm. *l. c.*

Myobia (Heyden). Body elongate, many-lobed; rostrum styliform.

M. musculinus, Schranck, p. 501, pl. 1.

f. 5. *Sarcoptes musc.*, Koch, *Crust. &c.* fasc. 5. pl. 13; On the mouse, Murray, p. 315.

Hypopus. See HYPOPUS.

A destructive disease in the sugar-cane is caused in various parts of the world by a minute red *Acarus*, which swarms round the stem.

BIBL. Dugès, *Ann. d. Sc. Nat.* 2 sér. ii. p. 40; Koch, *Deutschl. Crust.*; Walckenaer, *Aptères*, 3 (Gervais); Fumouze and Robin, *Journ. d. l'Anat.* 1867, 505, 561; Boisduval, *L'Entomol. horticole*, p. 76; *Mic. Soc. Jn.* 1880, *Glyc.* dev. p. 249; Murray, *Ec. Ent.* 1880; Mégnin, *Parasites*, 1880.

ACAU'LON, C. Müller.—A genus of Phascaceæ (Acrocarpous Mosses), taken as a section of *Phascum* by Wilson. *A. muticum* is common on moist banks.

BIBL. Müller, *Synops. Musc.* i. p. 21; Wilson, *Bryol. Brit.* p. 29.

ACEPH'ALOCYSTS.—A term used to denote certain simple sacs filled with a transparent liquid, found in the bodies of animals, and usually known as Hydatids by pathologists. They were formerly regarded as distinct parasitic animals; but recent observations show that they often consist of the cysts or larval forms of cestoid Entozoa. The cysts in many cases contain at first only an amorphous substance or a liquid. At a later period their real nature is determined by the presence of the included Echinococcus—head and hooks. The sacs or vesicles are oval or spherical, and vary in size from a pin's to a child's head. The walls of the sacs vary in thickness and transparence. They present no appearance of either head or body. In the larger cysts the walls are distinctly laminated. They exhibit no fibrous structure, but appear composed of a homogeneous substance closely resembling albumen in properties. Two species have been distinguished:—

A. endogena (*socialis* vel *prolifera*), the pill-box Hydatid of Hunter. This is met with in the liver, kidney, ovary, testis, and cavity of the abdomen. When developed in the substance of an organ, it is always enveloped by areolar tissue. The secondary cysts are detached from the inner surface of the parent.

A. exogena: in this the progeny is developed from the outer surface; found in the ox and other dometic animals.

In the examination of cysts supposed to be hydatids, careful search should be made for the hooks of *Echinococcus* or *Cysticercus* which can frequently be found when no further remains of the body are distinguishable. The hooks are figured in Pl. 21. fig. 1*b*. See ENTOZOA and ECHINOCOCCUS.

ACERVULI'NA, Schultze.—Under this name Schultze, in 1854, grouped as a genus some of the adherent varieties of *Planorbulina variabilis*, D'Orb., that have an irregular growth, with *heaped* chambers. They are found in warm seas, attached to algæ and other bodies. The word "acervuline" is applied to any such wildly aggregated growth in Foraminifera.

BIBL. Schultze, *Organism. Polythal.* 67; Carpenter, *Forum.* 209.

ACETIC ACID.—This is the well-known acid of vinegar.

It occurs in the juice of the flesh of animals; sometimes in the stomach in indigestion; also in the human blood after the use of alcoholic liquors, and in that of animals whose food has been soaked in spirit. It is also a common product of the decomposition of vegetable substances, both by fermentation, and in distillation, as well as a component of the natural plants, mostly combined with lime or potash; it is also a rare constituent of some mineral waters.

The only salt of this acid requiring mention is the *acetate of copper* (neutral), which is made by dissolving common verdigris in excess of dilute acetic acid, filtering and crystallizing upon the slides. The crystals, when mounted in Canada balsam, exhibit well the phenomena of dichroism. Pl. 39. fig. 2.

Acetic acid is one of the most common and valuable micro-chemical reagents. It is particularly useful on account of its action upon animal cells in general, rendering the cell-walls transparent aud the nuclei more distinct. The ordinary strong acid (sp. gr. 1044) should be used.

ACETINOP'SIS, Kent.—A genus of Infusoria, family Ophryodendridæ.

BIBL. Kent, *Man. Infus.* 1880.

ACHARAD'RIA, Wright.—A genus of Hydroid Zoophytes.

A. larynx resembles in habit *Tubularia larynx*; polypes orange. Marine; on stones.

BIBL. Str. Wright, *Qu. Mic. Jn.* 1865, iii. p. 50; Hincks, *Brit. Zoophyt.* p. 133.

ACHE'TA.—A genus of Orthopterous insects, one species of which, *A. domestica*, the house-cricket, is familiar to every one. The general structure of this insect agrees so closely with that of *Blatta orientalis*, the common cockroach or black beetle, which is

described at some length, that it requires no special notice here. (See BLATTA.) Some parts of the internal structure of the cricket are very beautiful, as the tongue (Pl. 33. fig. 23), the gizzard (Pl. 34. fig. 1), and the ear in the fore legs (Pl. 34. fig. 7*b*). These, as also the curious mechanism by which the chirping noise of the male is produced, are described under INSECTS.

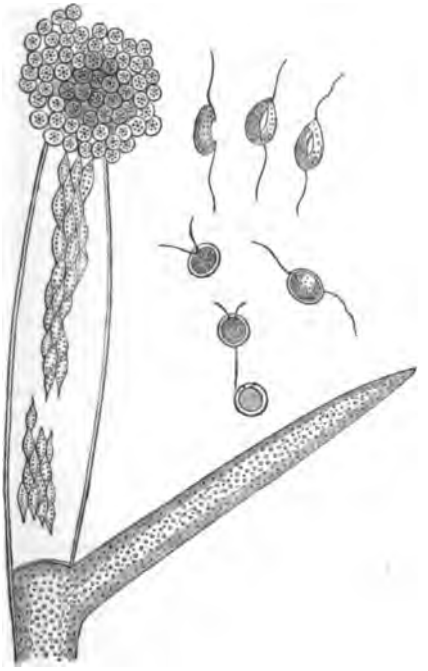
ACH'LYA, Nees (*Saprolegnia*, Kützing). —Remarkable microscopic plants, sometimes referred to the Algæ, but more properly belonging to Fungi. Cienkowski has recently confirmed the idea formerly entertained, that *Achlya* is an aquatic form of the Mucorinous Fungus called SPORENDONEMA *Muscæ* (*Empusa Muscæ*, Cohn), the common fly-fungus. Cohn and Al. Braun deny the identity, while Berkeley thinks *Achlya* may be an aquatic form of *Botrytis Bassiana*. They are found growing parasitically upon the bodies of dead flies lying in water, also upon fish—as salmon, salmon-eggs, frogs, &c., and in some cases upon decaying plants. To the naked eye they appear like colourless minutely filamentous tufts, adherent to such objects, forming a kind of gelatinous cloud more or less enveloping them. When placed beneath the microscope, the tufts are seen to consist of long, colourless, tubular filaments, spreading out in all directions, with or without lateral branches; these erect filaments arise from a kind of mycelium of ramified filaments lying upon the object upon which the plant grows. The erect filaments are devoid of septa, narrowed upwards, and vary in thickness, being usually of smallest diameter in those cases where they are closely crowded; the ordinary thickness varies from 1-1000 to 1-350 of an inch. The tubes contain a colourless slightly granular protoplasm, which is denser on the walls; and these sometimes exhibit an irregular spiral arrangement of the granules; the granules are seen to move slowly in anastomosing currents running in various directions, exhibiting, that is, the well-known phenomenon of the circulation of cell-contents, such as is met with in the hairs of *Tradescantia*, &c. The walls of the tubes are coloured blue by iodine and sulphuric acid, therefore consist of cellulose; the contents are nitrogenous, taking a bright yellowish brown with iodine; no trace of starch or chlorophyll can be detected in the cell-contents in this stage, whence these plants are regarded by some authors as Fungi; but, as mentioned hereafter, Pringsheim states that their ripe spores do contain starch.

Kützing describes a number of species of this genus, under the name of *Saprolegnia*, while a recent observer, Pringsheim, regards them all as forms produced by varying external conditions. A. de Bary separates *Achlya prolifera*, Nees, from *Saproleynia ferax*, Kützing, referring to the former the *Saprolegnia ferax* of Carus and the *Saprolegnia capitulifera* of Alex. Braun, to the latter the *Achlya prolifera* of Carus, and, doubtfully, the *S. molluscorum* of Nees and Gruithuisen. The distinction between these is said to lie in the details of the formation and emission of the active gonidia or zoospores; but we cannot make out satisfactory differences.

The following details respecting the formation of the active gonidia and the resting spores are given at length on account of their well illustrating modifications of free-cell formation. In about thirty-six hours after the appearance of a specimen on any body, the apices of the erect filaments exhibit remarkable changes. The granular protoplasm, which at first is equally diffused throughout the tube, only densest where it lies on the wall, increases in quantity and "travels up" into the end of the tube, becoming accumulated there, giving it a brownish colour and at the same time causing its distention, so that the upper part of the tube acquires a clavate form, rounded off above. A sharp line of demarcation is soon formed by the division of the primordial utricle, followed by the production of a septum, which shuts off this clavate joint as the sporange; and a little projecting pouch or beak is developed at the summit, or sometimes a little below this on one side. The contents, becoming still more condensed, again apply themselves as a thick investment on the wall, leaving a lighter space in the middle of the cavity. Inequalities, or nodular protuberances, are soon observable in this layer; and it speedily becomes broken up into numerous little isolated portions, individualization of these commencing at the summit of the sporange and becoming completed gradually from above downwards. The end-cell is now a clavate sporange filled with numerous polyhedral or globular new "primordial cells," in the development of which from the contents of the general parent-cell no trace of nuclei or "special parent-cells" can be detected; their size is about 1-2700 of an inch; and they have

clearly defined outlines, but are still connected together by a gelatinous substance in which they are completely imbedded. These secondary cells then become retracted from the walls, and accumulate in a dense, rather confused looking mass in the centre of the sporange; endosmose of water through the now bare cellulose wall of the sporange seems to exert a pressure upon them, and also on the wall itself, which finally bursts at the process or beak mentioned above, and the secondary cells nearest the opening are shot out with some force, the rest following, but gradually more quietly. There is no independent motion of the contents, or jerking of the secondary cells, before this emission of the latter; on the contrary, while in the

Fig. 1*.



Achlya prolifera, discharging its zoospores: the lower zoospores treated with iodine; magnified 400 diameters.

sporange, they adhere so closely that their shape is scarcely distinguishable, and it is only when the greater portion have escaped that it is perceived that the pressure had caused them to assume a spindle-shape. As the emission of the secondary cells goes on, those escaping first are only removed so far as to make room for their successors, and the whole remain adherent together as a globular mass or "capitulum" seated on the apex of the sporange; they reassume, more or less completely, the spherical form, by degrees, after they have escaped from the sporange: those which can expand freely become globular; those pressed upon by their fellows become polyhedral. At the time of emission, these secondary cells exhibit a double line at the circumference, which seems to indicate the thickness of the primordial utricle. Soon after the expulsion another delicate line is detected external to these; and this indicates a newly produced envelope, which becomes thicker with age, and after a certain time can be coloured blue by sulphuric acid and iodine, which demonstrates its composition of cellulose. Application of a strong acid is necessary for this purpose.

The globular head of secondary cells remains for two or three hours attached upon the summit of the empty, colourless sporange. Then these minute cells emit their contents by a lateral orifice, giving origin, each of them, to a zoospore or active gonidium. Neither the motion nor the appearance of cilia follows the expulsion immediately, but takes place after the gonidia have increased somewhat in size and acquired an ovate form. The duration of the motion lasts from a few seconds to a few minutes, after which the gonidium sinks to rest and begins to germinate. The gonidia possess no cellulose membrane while in motion, but acquire one when they come to rest and germinate. The cilia are two, and arise from the point which first emerged from the parent vesicle, and which at all periods exhibited a lighter tint, indicating a vacuole in the protoplasmic mass. If the expulsion of the gonidia is prevented (as occurs sometimes when the plant is kept under the pressure of a glass slide, in too little water, in microscopic investigation of it), the gonidia germinate within their cell-membranes, which, instead of discharging active zoospores, emit germinating prolongations, just like those issuing from the single germinating gonidia. These spread out here in all directions from the globular *capitulum*, still seated on the end of the sporange.

During the formation of these sporanges and the gonidia, after the septum has been completed, the tube sends out lateral branches from just below it, which some-

times equal the sporange in length by the time the latter discharges its contents; then this branch becomes developed as a sporange, either at its summit or in its whole length, or, when the branch is very short, the portion of the main tube below the first septum becomes a sporange. Sporanges of a third rank may succeed to those of the second rank, and so on, until the plant has exhausted the supply of food at its service. In another form the active gonidia are produced at once in the sporanges, without the intervention of secondary cells; and then they begin to move even before leaving the parent sac.

Achlya prolifera also produces, though more rarely, globular or spindle-shaped sporanges, either terminal or borne on special short lateral branches, in which are developed resting spores, characterized by a larger size, double cell-membrane, and by the absence of the cilia and consequent motion. The mode of their development is similar to that of the active gonidia; but they are much fewer in number, sometimes as many as twenty, sometimes only four, three, two, or even one being present in a sporange. When a number occur in a spindle-shaped sporange, they are ranged in two rows, alternately, so that each is partially interposed between its two opposite neighbours. Their diameter varies from 1-1250 to 1-750 of an inch, the colour brownish, displaying numerous oil-drops in the granular contents when mature. The sporanges producing them display a number of round orifices when the spores are ripe; but the spores appear to escape by the decay of the walls. These resting spores may remain unchanged in water for a long time when no suitable *nidus* exists, but will quickly germinate if a dead insect or similar object be thrown in.

The resting spores are from 1 to 20, while the active gonidia are from 5 to 150, the number depending in each case on the size of the sporange, not upon the size of the spores or gonidia, which is tolerably regular. Pringsheim states that starch occurs in the contents of the resting spores of *S. ferax*.

A third form of reproductive organ is described by Cienkowski, which in the earlier stages resembles a sporange of resting spores; but the spores produce each a long tubular neck, which bores through the wall of the sporange and discharges its contents as minute swarming bodies into the water; these have not been seen to germinate. These flask-shaped bodies resemble the formations seen by Carter in SPIROGYRA; and we have seen them in other Algæ. Al. Braun at first described them as a species of CHYTRIDIUM, but subsequently has expressed an inclination to regard them as *antheridial* spores of *Achlya*.

In addition to the above, Al. Braun has described curled tubular processes, resembling the horns of *Vaucheria*, associated with the sporanges in which resting spores are formed; and he is inclined to regard them as *antheridia* exercising a fecundating office, like the horns of *Vaucheria*. Similar bodies have been recorded in other *Saprolegniæ*, especially in *Achlya cornuta*. (See Pl. 27. figs. 22–27).

A. lignicola is found upon wood in water.

BIBL. A description of the supposed species will be found in Kützing's *Sp. Algarum*, p. 159. For further information on the development, see Al. Braun's *Rejuven.* (*Ray Society*, 1853, pp. 188, 268); Pringsheim, *Nova Acta*, xxiii. pt. 1. p. 397–400, 1852; Anton de Bary, *Bot. Zeit.* x. p. 473, 1852; Unger, *Linnæa*, 1843, p. 129 (*Ann. d. Sc. Nat.* 3me sér. ii. p. 5. pl. 1, 1844); Meyen, *Pflanzenphys.* iii. 457; Nägeli, *Zeitschr. für Wis. Bot.* heft 1, p. 102, heft 3, 4, p. 28 (*Ray Soc.* 1845, p. 278, 1849, p. 101); Thuret, *Ann. d. Sc. Nat.* 3me sér. t. xiv. p. 20, p. xxii, 1851; Ch. Robin, *Végét. Paras.* 2nd edit. 1853, p. 372; Varley, *Tr. Mic. Soc.* iii.; Cienkowski, *Bot. Zeit.* xiii. p. 801; Al. Braun, *Chytridium, Abh. Berlin. Ak.* 1855; *Verjüng. in d. Natur*, p. 318 (*Ray Society*, 1853, p. 298). A list of all the writers who had treated of *Achlya* before 1843 is subjoined to Unger's Essay in the *Linnæa*; Pringsheim, *Jahrb.* Bd. 1. heft 2, bd. 2. heft 2; Archer, *Qu. Mic. Jn.* 1867, p. 126; Sachs, *Bot.* 1874, p. 276; Pfitzer, *Monatsber. d. Berl. Akad.* Mai 1872; *Grevillea*, March 1878 (woodcuts).

ACHNANTHES, Bory.—A genus of Diatomaceæ (Cohort Achnantheæ).

Char. Frustules compressed; either single, in pairs, or united into a straight filament; geniculate in front view, without septa; attached by a stipes fixed to one angle; uppermost valve with a longitudinal median line, lowermost with a longitudinal line, and a median nodule or stauros.

The individual frustule, when single, or the lowermost when they are united, is furnished with a stipes or stalk, arising

from one end of the lower margin. Side view of frustules elliptical, oblong or linear, sometimes slightly constricted in the middle; markings of upper and lower valves different, the upper (Pl. 16. fig. 2) exhibiting transverse rows of dots (appearing like striæ under a low power) interrupted by a longitudinal line, the lower (Pl. 16. fig. 3) being also furnished with transverse rows of dots, interrupted by a stauros, as also by a longitudinal line which in some has a nodule at each end. The valves being much compressed, the transverse rows of dots appear also in the front view. The hoops exhibit faint longitudinal and sometimes transverse striæ.

Achnanthes resembles *Striatella* in its stalked flag-like filaments, but may be known from it by the absence of internal siliceous plates or vittæ.

Species:—

Freshwater; markings faint (minute) *A. exilis**.
Marine or brackish water; markings distinct.
Stipes longer than frustules ..... *A. longipes*†.
Stipes shorter than frustules.
Ends of valves acute ..... *A. brevipes*.
Ends of valves obtuse ..... *A. subsessilis*.

* Pl. 16. fig. 4. † Pl. 16. fig. 1.

Kützing enumerates 15 species of *Achnanthes*.

Bibl. Ralfs, *Ann. N. Hist.* xiii. 489; Kützing, *Bacill.* p. 75, & *Sp. Alg.* p. 54; Smith, *Brit. Diat.* ii. 25; Rabenhorst, *Fl. Alg.* 109.

ACHNANTHIDIUM, Kütz.—A genus of Diatomaceæ (Cohort Achnantheæ).

Char. Those of *Achnanthes*, mostly single, and without the stipes.

Five British species; freshwater:—

Filament of numerous frustules ... *A. lanceolatum*.
Frustules few, valves constricted in middle. ..... *A. coarctatum*.
Frustules few, often straight; valves constricted near the end..... *A. microcephalum**.
Frustules few; valves obtuse, unconstricted ..... *A. lineare*.
Frustules few, median line sigmoid *A. flexellum*†.

* Pl. 16. fig. 5. † Pl. 16. fig. 6.

Frustules very small, and markings very faint.

Bibl. Smith, *Brit. Diat.* ii. 30; Kützing, *Bacill.* 75, & *Sp. Alg.* 53.

ACHO'RION, Link and Remak.—The generic name applied to one of the vegetables occurring in *Favus*, and characteristic of that disease of the skin (also called *Porrigo* or *Tinea favosa*). The structure of the plant, *Achorion Schœnleinii*, bears much resemblance to that of the genus *Torula*; but it occurs in definitely bounded patches having a special arrangement of the microscopic elements of which it is constituted.

Much has been written by medical authors regarding these bodies; but we shall not enter into this part of the subject here, further than to state that the presence of this vegetable structure seems to be essential and causative in the disease of the skin to which we have alluded. Remak was unable to make any of the spores germinate in or on animal substances; some however emitted prolongations when placed upon an apple; but the surface then decayed and turned brown within the week, and became covered with mildew (*Penicillium glaucum*). One of the entire corpuscles kept upon the arm for several days, fell off without leaving any mark; but a fortnight after a *favus* began to be developed. Gruby states that he inoculated various parts of the body with it, and even caused it to grow upon wood(?). Bennett ultimately confirmed the statements of Gruby as to the inoculation.

Unfortunately, most authors who have written on the parasitic fungi which occur in morbid conditions of the human frame, or are productive of disease, have not been well acquainted with either Fungi or Algæ. Numberless names have been assigned to them; and in consequence, while many of these organisms have been considered Algæ, they have been regarded by others as Fungi. It is, however, probable that all of them are mere conditions of the most universally diffused species of *Penicillium*, *Aspergillus*, *Mucor*, or *Cladosporium*—genera which are capable of propagation by cells thrown off from the threads, other than the normal fruit. It is quite impossible that, as supposed by Ardsten, such a genus as *Puccinia* could be produced on animal tissues.

Bibl. Ch. Robin, *Vég. parasites*, 1853, (plates, 2nd edit.); Bennett, *Month. Jn. Med. Sc.* 1850 (figs.), and *Tr. Roy. Soc. Edinb.* 1842, xv. pp. 227–294; Gruby, *Compt. Rend.* 1841, xiii. p. 72; *Mycodermes &c., ibid.*, 309; *Tinea favosa, Müller's Archiv*, 1842, p. 22; Hannover, *Müller's Arch.* 1842, p. 281–295, pl. 15. figs. 7–9; Müller and Retzius, *Müll. Archiv*, 1842, p. 192, pl. 8 and 9; Lebert, *Phy. Path.* ii. p. 477, Paris, 1845; Remak, *Diagn. u. pathogen. Unters.* Berlin, 1845, p. 193–215; Bazin, *Les Teignes*, Paris, 1853, 8vo (plates); Robin, *Micr.* 1877, p. 860.

ACHRO'MATISM. — A term properly signifying freedom from chromatic aberration, but commonly used to denote freedom from both spherical and chromatic aberration.

ACICULA'RIA, D'Archiac.—One of the Foraminifera imperforata, related to *Dactylopora*, and consisting of numerous chambers arranged in close order side by side without intercommunication, and forming minute aciculate cylinders, or narrow tapering plates. Known fossil only in some Tertiary beds of France.

BIBL. Carpenter, *Introd. Foram.* 137.

ACINE'RIA, Duj.—A genus of Infusoria, of the family Trichodinia.

Char. Body oblong or lanceolate, depressed, the fore part somewhat obliquely recurved like the blade of a sabre; a row of cilia, directed forwards, arising from one side.

Differs from *Trachelius*, Duj., in the arrangement of the cilia and in the anterior curvature; devoid of a mouth, like *Trachelius*, which especially distinguishes the present genus from *Pelecida*. 2 species:

A. incurvata (Pl. 30. fig. 1); marine, colourless; length 1-500 inch.

A. acuta (Pl. 30. fig. 2), found in fresh water; length 1-580 inch.

Dujardin figures in the latter species cilia upon both margins, those on one side being directed forwards, and those on the other backwards.

Claparède and Lachmann refer these to *Amphileptus*.

BIBL. Dujardin, *Infus.* p. 402; Clap. and Lachm. *Inf.* p. 356.

ACINETA, Ehr.—A genus of Rhizopoda, belonging to the family Acinetina.

Claparède and Lachmann enumerate 8 species.

A. mystacina (Pl. 51. fig. 11). Yellowish brown, rounded, tentacles in two bundles; 1-120 to 1-800. On *Lemna minor*.

A. patula (Pl. 51. fig. 12). Body as if resting on a cup-shaped carapace, variable in form; contains brown granules. On marine Algæ. Norway. Length 1-100″.

A. tuberosa (Pl. 30. fig. 4). Colourless or yellowish brown, triangular when expanded; tentacles arising from the distal angles only. Salt or brackish waters; 1-100″ to 1-410″.

A. Lyngbyi, ferrum-equinum, and *cylindrica* are referred by Cl. and Lachm. to *Podophrya*.

A. Notonectæ. On the hairs of the legs of *N. glauca*.

BIBL. Pineau, *Ann. d. Sc. Nat.* 3 sér. Zool. iii. & ix.; Ehr. *Inf.*; Duj. *Inf.*; Claparède and Lachmann, *Etudes, &c.*; *Ann. N. H.* 1857, xix.; Stein, *Infus.*; Gegenbaur, *Morph. Jahrb.* 1875.

ACINETI'NA, Ehr.—A family of Radiolarian Rhizopoda.

Char. Those of the Actinophryina, but with usually capitate and suctorial tubular tentacles, the body being more or less enclosed in a carapace, which is generally prolonged to form a stalk.

The structure and relations of these animals are still very unsettled. The researches of Pineau and Stein tended to render the existence of the species doubtful, by showing that they were stages of development of *Epistylis, Vaginicola, Vorticella*, &c.; but this has since been found to be incorrect. They exhibit a nucleus, and one or more contractile vesicles. The remarkable suctorial character of the tentacles has not been proved to occur in all the genera and species. Many, however, have been seen to take food voraciously, which is thus effected: when an Infusorium touches the button-like end of the tentacle, it usually remains adherent to it; the end becomes still more dilated so as to constitute a sucking disk, and the ray becomes thicker and shorter, the other rays at the same time making grasping movements and endeavouring to attach their extremities to the captured prey. A current of chyme-particles is then soon seen running from the captured infusorium into the body of the *Acineta*. The chyme-particles form at first a slender row, but afterwards collect in a drop. The body of the *Acineta* then becomes opaque, from the collection of the drops.

The colourless or coloured ova described by Ehrenberg are partly chyme-particles, partly oil-drop-like globules which make their appearance in the *Acinetæ* after animal food. The ciliated swarm-germs to which they give origin have been traced directly into *Acinetæ*. Fission has been observed in *Acineta mystacina*, not in the others. The genera may be thus divided:

*Tentacles not borne upon a proboscis.
Tentacles unbranched.
Stalks simple.
No shell: A peduncle ..... 1. *Podophrya.*
No shell: No peduncle: free .. 2. *Sphærophrya.*
No shell: No peduncle: fixed. 3. *Trichophrya.*
A shell: Peduncle present. 4. *Acineta.*
A shell: Peduncle absent... 5. *Solenophrya.*
Stalks branched ..... 6. *Dendrosoma.*
Tentacles branched .... 7. *Dendromycetes.*
**Tentacles borne on a long proboscis ..... 8. *Ophryodendrion.*

Here belong, perhaps, the genera *Corethria, Ephelota,* and *Zooteira* (Wright); and Alder's animalcules.

ACO'MIA, Duj.—A genus of Infusoria, of the family Enchelia.

Char. Body oblong-ovate or irregular, colourless or granular, turbid, composed of a glutinous homogeneous substance containing irregular granules, and ciliated only or principally at one end. Dujardin describes eight species, to which Perty adds one.

Marine, or inhabiting decomposing infusions. Minute and colourless.

A. vitrea (Pl. 30. fig. 3); freshwater; length 1-868.

BIBL. Duj. *Infus.* p. 382; Perty, *Zur Kenntniss, &c.* p. 149.

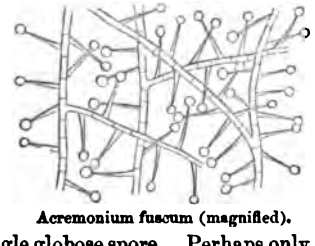
ACONTIOPH'ORUS, Brady. A genus of Entomostraca, Ord. Copepoda.

A. scutatus and *A. armatus*; marine; around the British coasts.

BIBL. Brady, *Copepoda (Ray Soc.)*, 3. p. 69.

ACREMO'NIUM, Link.—A genus of Hyphomycetous Fungi, belonging to the division Mucedines; distinguished by its jointed threads bearing numerous patent branchlets, each of which is terminated by

Fig. 2.



Acremonium fuscum (magnified).

a single globose spore. Perhaps only states of some other genus. British species:

A. verticillatum, Link. On dead wood, trunks of trees.

A. alternatum, Link. On decaying leaves.

A. fuscum, Schmidt (fig. 2). On dead wood and sticks.

A. ranigenum, B. and Br. On dead frogs. Distinguished by the threads being matted together below into a distinct stem.

BIBL. *Engl. Flora*, v. pt. 2. p. 347; Greville, *Scott. Cryp. Fl.* t. 124. figs. 1 and 2; Berk. and Br. *Ann. N. Hist.* 1871, June.

ACROCAR'PI.—An artificial division of Mosses (see MOSSES).

ACRO'PERUS.—A genus of Entomostraca, of the family Lynceidæ (Baird).

Char. Shell somewhat harp-shaped, the anterior inferior margin projecting and obtusely angular, inferior antennæ long; beak blunt, very slightly curved downwards; shell striated with longitudinal ribs directed obliquely downwards and forwards; colourless. 2 species:—

A. harpæ (Pl. 19. fig. 1); each branch of inferior antennæ with 3 long setæ from the extremity of the last joint only.

A. nanus (Pl. 19. fig. 2), much smaller than the last; anterior branch of inferior antennæ with 4 setæ, one arising from the second, and three from the end of the last joint.

This genus is scarcely distinct from *Camptocercus.*

BIBL. Baird, *Ann. N. Hist.* xi. 91; and *Brit. Entomos.* 129.

ACROSPER'MUM, Tode.—A genus of Sphæronemei (Stylosporous Fungi), consisting of minute, somewhat cartilaginous perithecia, a few lines high, discharging long, wavy, erect, simple, microscopic spores from a terminal pore or ostiole. British species:—

A. compressum, Tode. On dry stalks of herbaceous plants.

A. graminum, Libert. On dead grasses.

A. cornutum, which is not uncommon on the gills of blackened Agarics, is merely the winter resting-state of *Agaricus tuberosus.*

BIBL. *Engl. Flora*, v. pt. 2. p. 221; Grev., *Sc. Crypt. Flora*, t. 182.

ACROSPO'RIUM, Nees.—A generic name formerly applied to certain species of *Oidium* (see OIDIUM).

ACROSTALAG'MUS, Corda.—A genus of Mucorini (Phycomycetous Fungi), distinguished by its whorled branched septate threads, each branch terminated by a globose vesicle, which is pierced by the tip of the branchlet, from which numerous spores are given off within the vesicle.

Verticillium lateritium is a form of this beautiful mould, with minute naked spores.

Fig. 3.

Acrostalagmus cinnabarinus (highly magnified).

The accompanying figure represents *Acrostalagmus cinnabarinus,*

Corda. It grows in large patches on rotten potatoes. Hoffmann regards it as a mere form of *Trichothecium roseum*, which is rather a *Dactylium*.

BIBL. Berkeley, *Cryptog. Bot.* p. 294; see also TRICHOTHECIUM and VERTICILLIUM.

ACROSTICH'EÆ.—A family of Polypodiaceous Ferns, with naked sori.

Illustrative Genera.

Acrostichum. Sori seated on all the veins, venules, and parenchyma, sometimes on both surfaces; veins very much branched, and anastomosing in more or less regular meshes.

Platycerium. Sori forming large patches on the lower surface of the fertile fronds, which are dichotomously forked with stag's-horn-like divisions.

ACROS'TICHUM, L.—A genus of Acrostichæ (Polypodiaceous Ferns), with naked sori seated on all parts of the leaf. Species very numerous, mostly tropical. See HAIRS.

ACTIN'IA.—A genus of Cœlenterata (Zoophytes); class Actinozoa.

Char. Body conical or cylindrical, adhering by a broad discoidal base; mouth simple, superior, surrounded by one or more uninterrupted series of conical, undivided, tubular retractile tentacula; marine.

The species are commonly known as sea-anemones, and are found on the sea-coast adhering to rocks and stones. *A. mesembryanthemum* (1-1½″ diam.), with numerous azure-blue tubercles surrounding the margin of its oral disk, is very common on the British coast.

The body is formed of a thick coat, the inner layer of which consists of longitudinal and transverse unstriated muscular fibres. The tentacles are covered with stinging threads and capsules, as in the Acalephæ, often forming beautiful objects; and at their bases are often found chromatophores. The space between the stomach and the skin is divided into cellular spaces by radiate partitions or mesenteries, the ovaries and the spermatic convoluted tubes being attached to these partitions.

The connective tissue of the body is composed of numerous fibres, cells, and intermediate stages, of extreme delicacy (Pl. 41. fig. 1). Dispersed throughout it are numerous spindle-shaped, flexible, organic spicula (Pl. 41. figs. 1 *a* and 2), many of them curiously marked by interrupted transverse markings (fig. 2).

In reproductive power they almost equal the Hydræ; when cut across, new tentacles form in a few weeks on the lower half, and each piece becomes a new animal. They are usually propagated by ova; the embryos being ciliated. Many of the species exhibit the most splendid iridescent colours.

BIBL. Johnston, *Brit. Zooph.*; Tugwell, *Common English Sea-Anem.*; Gosse, *Actinol. Britann.* 1860, *Mar. Zool.* 1, and "*Devonshire Coast*;" Bronn, *Die Klass. &c. d. Thierreichs*; Gegenbaur, *Vergl. Anat.* 1878; Nicholson, *Zool.* p. 178; Stricker, *Human & Comp. Histol.*

ACTINIS'CUS, Ehrenberg.—A doubtful genus of Diatomaceæ, provided with siliceous shells bearing radiating spines. (Cohort Actiniscææ.)

Char. Individuals microscopic, solid, radiate, resembling a star; marine.

These organisms, which are found both recent and fossil, are especially remarkable for their valves being frequently found perforated. Species:—

A. Tetrasterias, Ehr. (Pl. 18. fig. 1). Stellate, with 4 free rays; diam. 1-1000″. Virginia.—*A. Pentasterias*, Ehr. (Pl. 18. fig. 2). Rays 5; diam. 1-1200″. Recent on the shores of Norway; fossil in the chalk-marl of Greece.—*A. quinarius*, Ehr. (Pl. 18. fig. 3). Stellate, rays 5, free; diam. 1-3000″. Ægina.—*A. Sirius*, Ehr. (Pl. 50. fig. 45). Rays 6, acute, winged at the base; diam. 1-1200″. Shore of Norway, recent.—*A. Discus*, Ehr. (Pl. 18. fig. 4). Disk-shaped, centre smooth, 8 marginal rays not exserted; diam. 1-1200″. Oran.—*A. Rota*, Ehr. (Pl. 18. fig. 5). Disk-shaped, centre smooth, 10 marginal rays exserted; diam. 1-1900″. Oran.—*A. Lancearius*, Ehr. Stellate, with 8 marginal lanceolate rays, and some central rays which are shorter on one side; diam. 1-240″. Antarctic Ocean.

BIBL. Ehrenberg, *Leb. Kreidethierchen*, 1840, p. 69; *Monatsber.* 1844, p. 76, &c.; Kützing, *Bacillarien*, 1844, p. 139; *Spec. Algarum*, 1848, p. 141.

ACTINOB'OLUS, Stein.—A genus of Infusoria.

BIBL. Kent, *Infus.* 1880, p. 214.

ACTINOCLA'DIUM, Ehr.—A genus of Mucedines (Hyphomycetous Fungi). No British species yet recorded.

ACTINOCOC'CUS, Kützing.—A genus of exotic Algæ (marine), referred to *Ri-*

vularia by Suhr (Kütz. *Tab. Phyc.* 31, fig. 2).

ACTINOCY'ATHUS, Kent.—A genus of Infusoria.

Bibl. Kent, *Man. Inf.*

ACTINOCYC'LUS.—A genus of Diatomaceæ (Cohort Coscinodisceæ).

Char. Frustules solitary, free or adherent to other bodies; disk-shaped; valves circular, exhibiting cellular markings, with rays or bands radiating from the centre, which is free from the cellular appearance; no internal septa; marine.

The cellular appearance arises from the existence of depressions upon the surface. The radiant bands arise from undulations of the surface, which are best seen in the front view (Pl. 25. fig. 17 *b*).

A. undulatus (Pl. 25. fig. 17 *a*); rays 6, diam. 1-250 to 1-1100″.

Kützing enumerates 34 species; some are found fossil.

Smith admits *A. duodenarius* (rays 12), *A. sedenarius* (rays 16), and *A. octodenarius* (rays 18) as British—species referred by Ehrenberg and Kützing to the genus *Actinoptychus*. These are found in the Medway.

Bibl. Ehrenberg, *Leb. Kriedethierchen*, 1840, p. 57; *Monatsber.* 1844, and *Mikrog.*; Kützing, *Bacillar.* 1844; *Sp. Algarum*, 1849; Roper, *Mic. Jn.* ii.; Smith, *Brit. Diat.* i. 25, and ii. 86; Rabenhorst, *Fl. Alg.* 35.

ACTINODIS'CUS, Grev.—A genus of Diatomaceæ.

Char. Frustules free, disk-shaped; valves granular, with a central nucleus, and numerous (15) linear smooth rays extending from it to the margin.

A. Barbadensis (Pl. 36. fig. 22). Diam. 1-250″. In the Barbadoes deposit.

Bibl. Greville, *Micr. Trans.* 1863, 69.

ACTINOGO'NIUM, Ehr.—A genus of Diatomaceæ.

Char. Prismatic, frustules not forming a filament, subspherical, with 7 or more angles.

A. septenarium (Pl. 18. fig. 8). With 7 angles. Found fossil in Barbadoes earth, with Polycystina.

Bibl. Ehr. *Monatsber. d. Berl. Ak.* 1847; *Ann. N. Hist.* vol. xx. p. 127.

ACTINOM'ONAS, Kent.—A genus of Infusoria, Ord. Flagellata (Radio-flagellata, Kt.).

Char. Resembles a stalked *Actinophrys* with a long anterior flagellum; neither test nor central capsule.

2 species:—*A. mirabilis* (Pl. 53. fig. 1); diam. 1-2000″. *A. pusilla*; diam. 1-3250″.

Bibl. Kent, *Infus.* p. 227.

ACTINOPHRYI'NA, Duj.—A family of Radiolarian Rhizopoda.

Char. Body usually rounded, contained in a shell or shell-less, giving off radiate non-agglutinating pseudopodia, either from the entire surface, or from parts only; spicules and spines absent.

The genera may be divided thus:—

Shell absent.
- Pseudopodia arising from all parts of the surface ..... *Actinophrys.* (*Acanthocystis.*)
- Pseudopodia arising from a zone near the circumference ..... *Trichodiscus.*
- Pseudopodia arising from one side ..... *Plagiophrys.*

Shell present.
- Free.
  - Incrusted with foreign matter ..... *Pleurophrys.*
  - Not incrusted, oblong.
    - Orifice lateral ..... *Trinema.*
    - Orifice terminal ..... *Euglypha.*
- Attached to foreign bodies ..... *Urnula.*

Bibl. That of the genera.

ACTI'NOPHRYS, Ehr.—A genus of Actinophryina.

The species of *Actinophrys* are found in both fresh and salt water. The body exhibits contractile vesicles, mostly near the margin, but sometimes more diffused and giving it a cellular appearance. Conjugation has been repeatedly observed; but authors are not agreed upon its import. The movement of the pseudopodia is very slow; granules may be seen continually moving in them, as in the Gromida and Foraminifera; but the circulation is much slower, and requires great attention and a high power to render it visible.

A. sol, E. (Pl. 30. fig. 7 *b*). Spherical, colourless, whitish tentacles radiating from all parts of the body; 1 or 2 contractile vesicles strongly projecting on the surface; parenchyma not reticular; diam. 1-430 to 1-1200″; fresh water.

A. Eichornii, E. (Pl. 30. fig. 7 *a*). As *A. sol*, but parenchyma presentiug a more or less regular cellular appearance; diam. 1-100″.

A. marina, D. As *A. sol*, but marine, rather smaller, and movements of tentacles more rapid.

A. brevicirrhis, P. Greenish, not reticular; pseudopodia very short and very numerous.

A. pennipes, Cl. & L. Not reticular; pseudopodia few, slender, and very long; no projecting vesicle.

A. viridis, E. (Pl. 30. fig. 6). Spherical;

greenish; rays shorter than the body; diam. 1-280″ to 1-620″; fr. water. Perhaps *A. sol* coloured by chlorophyll.

A. digitata, D. Colourless, depressed, tentacles flexible, thickened at base, and when contracted forming finger-like prolongations; diam. 1-770″; fr. water.

A. granata, D. Spherical; opaque in centre; rays taper, shorter than body; fr. water.

A. paradoxa, Carter (Pl. 51. fig. 13). With numerous capitate and longer simple tentacles; fr. water. Bombay.

A. oculata, St.=*A. sol*? *A. discus*, D.=*Trichodiscus sol*, E. (Pl. 32. fig. 8). *A. pedicellata*, D=*Podophrya fixa*, E. *A. stella*, Perty=the eggs of one of the Rotatoria.

The manner in which these animals feed is curious. Any part of the surface of the body may be converted into a temporary stomach. When an infusorium or a minute alga comes into contact with one of the tentacles, it generally becomes adherent. The tentacle with the prey then slowly shortens, and the surrounding tentacles apply themselves upon it, bending their points around the captive, so that it gradually becomes enclosed on all sides. In this way the prey is gradually brought to the surface of the body. The spot at the surface of the body upon which the captured organism is lying slowly retracts, and forms at first a shallow depression, which gradually becomes deeper and deeper, in which the organism is finally lodged. As the depression becomes still deeper, its edges coalesce, and thus a cavity closed on all sides is formed, in which it remains for a certain time and becomes digested. If there be any indigestible residue, a passage for its exit is formed, and it is expelled by further contractions of the substance of the body, and in the same or a different direction from that at which it entered, the canal and the aperture entirely disappearing.

Bibl. Kölliker, *Zeitschr. f. wissens. Zool.* Bd. i. (*Qt. Micr. Jn.* i.); Stein, *Archiv f. Naturgesch.* 1849; Brightwell, *Infus. of Norfolk*; Pritchard, *Infus.*; Carter, *Ann. N. Hist.* 1864; Claparède and Lachmann, *Etudes*; Perty, *Z. Kenntniss &c.* p. 159.

ACTINOP'TYCHUS, Ehr.—A genus of Diatomaceæ. (Cohort Coscinodisceæ.)

Char. Frustules solitary, free, disk-shaped, with rays and internal radiating septa; valves apparently cellular (areolar), except opposite the rays.

The presence of true internal septa is doubtful; hence it becomes a question whether this genus should not be consolidated with *Actinocyclus*.

Kützing enumerates 16 species, distinguished principally by the number of septa and rays; *A. ternarius*, septa 3; *A. quaternarius*, septa 4; *A. senarius*, rays 6 (Pl. 25. fig. 16), &c. *A. hexapterus*, with 6 thick, solid conical rays, is one of the calcareous corpuscles of an echinoderm; the margin of the disk thick, undulate, and toothed within. Many of the species are fossil.

Bibl. Ehrenberg, *Infus. Abh. d. Berl. Akad.* 1838, and *Berl. Bericht.* 1844; Kützing, *Bacill.* 134; *Sp. Alg.* 130; Greville, *Micr. Trans.* 1866, p. 5; Rabenhorst, *Alg.* p. 35.

ACTINOSPHÆ'RA, Perty.—A doubtful genus of Rhizopoda.

Char. Body minute, spherical, surrounded with irregular, rather rigid processes. Movement that of swimming on various axes.

Processes stout and taper. Body colourless, containing greyish-green (food-) spots.

Bibl. Perty, *Zur Kenntniss &c.* p. 189.

ACTINOSPHÆ'RIUM = *Actinophrys*, in part.

ACTINOTHYR'IUM, Kunze.—A genus of Sphæronemei (Stylosporous Fungi), forming minute round, flat, black spots, with a central boss of close, radiating, fibrous structure. British species:—

Fig. 4.

Actinothyrium graminis (highly magnified).

A. graminis, Kunze. On leaves and stalks of Grasses in spring (fig. 4). The innate, radiately fibrous, shield-like perithecium finally dissolves at the apex. The stylospores, which are spindle-shaped, are formed beneath the disk, attached by their bases; Fries conjectures that they are transformed asci.

It is probably a state of some *Sphæria* or allied genus.

Bibl. Greville, *Crypt. Flora*, t. 218.

ACTINOT'RICHA, Kent.—A genus of Infusoria, fam. Oxytrichina.

ACTINU'RUS.—A genus of Rotatoria, of the family Philodinæa, Ehr.

Char. Eye-spots two, frontal (red); tail-like foot with 2 lateral horny processes and 3 terminal toes. (*Rotifer* with 5 points to the foot.)

Agrees with *Rotifer* in general structure; teeth 2 in each jaw (Pl. 43. fig. 2).

1 species, *A. Neptunius* (Pl. 43. fig. 1).

Colourless, body attenuated; length 1-18″ to 1-36″. Very common, aquatic.

ADELOSI'NA, D'Orb.—At first regarded as a generic form, but now recognized as only the young condition of some of the Milioline Imperforate Foraminifera. *Spiroloculina*, *Quinqueloculina*, and *Triloculina*, subgenera of *Miliola*, commence their growth, after the fashion of their congeners also, with a relatively large, subglobose "primordial chamber;" and the succeeding growth produces a curved flask-like chamber, closely enwrapping one side of the former. Until the successive lateral overlappings by new chambers build up the nearly oval outline of the adult *Miliola*, the young shell is one-sided, and may be termed "Adelosina." Found in all seas, and common among Tertiary and Cretaceous fossils at many places.

BIBL. Carpenter, *Introd. Foram.* 75; D'Orbigny, *For. foss. Vienne*, 301.

ADE'NOID or Retiform Tissue.—A variety of connective tissue, consisting of very fine fibres, forming a network, in the meshes of which are found numerous lymph-corpuscles. It forms the stroma of the spleen, the lymphatic glands, &c. The fibres are formed by the union of the processes of the original connective-tissue cells. See GLANDS of Animals, and LYMPHATICS.

ADENO'MATA. These are tumours composed of new formations of glandular tissue. They occur in the mamma, mucous membranes, the sebaceous and pineal glands, the ovaria, and the liver.

BIBL. Green, *Pathol.*; Rindfleisch, *Path.* 1878.

ADENOPLEU'RA, Macalister.—A genus of Acarina, fam. Ixodidæ.

A. compressum. Found between the scales of the West-African Pangolin (*Manis multiscutata*). L. 1-16″.

BIBL. Macalister, *Qu. Mic. Jn.* 1872, xii. p. 287 (figs.); Murray, *Econ. Entom.* p. 200 (fig.).

ADIANTUM, Linn.—A genus of Pterideæ (Polypodiaceous Ferns), with one elegant indigenous (fig. 5), and many exotic species.

ADULTERATIONS (Pl. 2).—A very important use to which the microscope is applicable, consists in the detection of various adulterations of articles of food, drugs, and products of the arts and manufactures.

The first point in a question of adulteration is, to determine, by microscopic and micro-chemical analysis, the structure and composition of the pure substance; and if the Table given at the end of the Introduction be kept in view in this proceeding, but few points will probably be overlooked. On then comparing these results with those obtained by a similar mode of proceeding in regard to a suspected substance, there will in general be found little difficulty in determining whether it is pure or not. If impurities or adulterating ingredients are present, the next point will be to determine their nature. To do this with certainty, would require that the structure and composition of every kind of substance, either natural or artificial, should be known, which would imply an amount of knowledge possessed by no one. But the question is simplified in practice, because substances used in adulteration must be cheap, and either grown or manufactured in quantities at home, or imported from abroad. Hence they are generally common, and it is pretty well known of what they will probably consist. In Plate 2 will be found the true structure of the adulterated articles and that of the adulterants. When the adulteration consists of a chemical substance as it might be called, *i. e.* a salt, metallic oxide, proximate principal, &c., its nature is readily determined by chemical analysis; but when it consists of a vegetable tissue, which has been perhaps subject to a partly chemical process of manufacture, the judgment must be based upon the form of the various parts, their size, relative position, and other particulars holding a place in the Table already alluded to.

Fig. 5.

Adiantum Capillus Veneris (pinnule with sori covered by indusia); 5 diam.

The following list of adulterations of articles of general consumption will serve as a guide to the inquirer, and as an index to the special articles in this work in which further details will be found.

ARROW-ROOT (Pl. 46. fig. 26).—Cheaper kinds of starch.

BREAD.—Mashed potatoes, bean-flour, rice, alum.

CAYENNE PEPPER.—Ground rice, mustard-husks, deal sawdust, formerly mineral colouring-matter of lead, &c.

CHICORY.—Roasted flours of corn and beans, acorns, mangold-wurzel, parsnips, carrots, mahogany-sawdust, burnt sugar, red ochre, &c.

CINNAMON.—Flour of grain and potato, cheap starches, &c.

COCOA and CHOCOLATE (fig. 4).—Arrow-root and other starches, flours, sugar, chicory, red ochre, &c.

COFFEE (fig. 5).—Chicory and its adulterations, as above, locust-beans, date-stones, and figs.

CURRY POWDER.—Flour, ground rice, red lead, red ochre.

FLOUR (Pl. 46).—Meal of other grains, beans, potato-starch, rice.

GINGER.—Flours of various kinds, mustard-husks, cayenne pepper, turmeric.

ISINGLASS.—Gelatine from bones.

LARD.—Potato-flour.

MUSTARD (fig. 11).—Flour, turmeric.

OAT-MEAL.—Barley-meal.

PEPPER and other spices (fig. 12).—Flours of grain, peas, potatoes, &c., ground mustard, linseed, rice-husks, &c.

PICKLES.—Dilute sulphuric acid (vitriol) instead of vinegar.

SUGAR.—Potato-flour, starches.

TEA (fig. 1).—Various leaves (sloe, elder), catechu, mineral colouring-matters, iron-filings, rice-husks.

TOBACCO (fig. 16).—Various leaves (dock, rhubarb, coltsfoot), paper, &c.

BIBL. Ure, *Dict. of Arts and Manufactures*; Mitchell, *Adult. of Food*; Normandy, *Hand-b. Commercial Analysis*; Schacht, *Prüf. d. im Handel vork. Gewebe*, 1853; Wiesner, *Mikroskop, &c.*; Angus Smith, *Rep. of Manchester Sanit. Assoc.* 1863; Hassall, *Food, &c.*; *Parlium. Rep. on the Adult. of Food, &c.*, 1855; and *Adult. detected*, 1857; Odling, *Journ. Soc. Arts*, 1858, vi. 318; Garnier and Harell, *Falsificat. d. Subst. Aliment.*; Pereira, *Mat. Med.*; Sorby *on Spectroscope, in Qu. Mic. Jn.* 1869, p. 358; Klencke, *Verfulsch. &c.* (illustr.), 1879; Soubeiran, *Dict. d. falsif. &c.*, 1874; Blyth, *Anal. of Food, &c.*

ÆCID'IUM, Persoon.—A genus of Uredinei (Coniomycetous Fungi), consisting of parasitic fungi infesting leaves and herbaceous stems, appearing in their full-grown condition as little cups filled with a reddish or brownish powder (spores), formed by a raising-up and bursting of the epidermis by the parasite developed within. Many may be detected in earlier stages by the deformities they produce in the growing structure of the plants infested, or by pale or reddish spots on the green surface, arising from the presence of the imperfect fungus underneath. These plants are commonly known under the name of blight, brand, &c. Their history has recently received much elucidation at the hands of Tulasne, De Bary, and others; and they are found to exhibit a more complicated organization than was formerly imagined. The organs of fructification are produced in two forms, bearing great resemblance to the conditions lately ascertained to exist generally in the Lichens. A brief account of the natural history of certain of the species, derived from De Bary and Tulasne, will give a general idea of the character of this genus.

The nascent *Æcidia* are observed as minute spots upon the herbaceous parts of the plants which they infest. When sections are made of these and placed under the microscope, it is found that the parenchyma of the plant is deformed, irregular, and interrupted by large intercellular passages, among which ramify the filaments of the mycelium of the fungus; these are delicate, much-branched and septate, about 1-3600 of an inch in diameter. At certain points these filaments are crowded and interwoven into hollow globular conceptacles, about 1-180 of an inch in diameter, immediately beneath the epidermis, the interior of which conceptacle is lined with delicate filaments (about 1-12000 of an inch in diameter) arising at all parts and converging towards the centre, except at the upper part, (which is open, and only shut from the external air by the persistent epidermis of the nurse-plant,) where they are directed upwards. A granular mass occupies the centre of the conceptacle, separating the converging filaments from each other. By the growth of the upper filaments and the increase of the central granular mass, the whole structure increases in size, so as to push the epidermis up above the surrounding surface, finally

bursting it, when the upper filaments (*paraphyses*) grow out through the orifice and form a little funnel-shaped tuft on the summit of the protuberance, through the middle of which the granular mass formed below makes its escape. These bodies may be found commonly on the spurges (*Æ. Euphorbiæ*), the barberry (*Æ. Berberidis*), nettles (*Æ. Urticæ*), Compositæ (*Æ. Compositarum*), &c., early in the season; later they may frequently be recognized in a dried-up condition, being forerunners of the true sporiferous bodies (Pl. 26. fig. 1). The name applied to these organs is *spermogonia*. The filaments converging into the centre of these, termed *sterigmata* (Pl. 26. figs. 2, 3, *s t*), are the important parts of the structure; they terminate in rows of minute bodies of oval form, about 1-6000 of an inch long and 1-12000 in diameter (ibid. *s p*), which become detached and separated, falling loose into the cavity, where, by a continued growth and shedding of similar bodies from the converging filaments, they accumulate to form the granular mass above spoken of as existing in that situation. The number ultimately becomes enormous, and a gelatinous substance is secreted, glueing them into a mass. When placed in water under the microscope, or when wetted by rain in its natural position, the ripe mass swells and is protruded through the orifice of the spermogonium on the surface of the leaf. By a longer action of moisture the jelly dissolves, and the minute bodies (*spermatia*) spread about in the water, exhibiting "an oscillatory motion, as of a body attached at one extremity." De Bary states that he found iodine arrest this motion, while it persisted for some time in solution of chloride of calcium. No cilia can be detected. Fresh spermatia were coloured bright purple red by sugar and sulphuric acid, but at the same time were so acted on that it could not be made out whether they possessed a membrane free from nitrogenous matter. Solution of potash renders invisible the outlines, not only of the spermatia, but of the sterigmata and paraphyses. The resemblance of these bodies to the spermatia of the Lichens (see LICHENS), is too evident to be mistaken; hence the same terms are applied to the corresponding organs.

The *spermogonia* occur either in regular groups, or scattered just like the *perithecia*; when the latter are on the same surface of a leaf, they often form a circle round the former. Frequently they burst through on opposite sides of a leaf; and then the *spermogonia* are oftenest on the upper, the *perithecia* on the lower face (Pl. 26. fig. 1 *sp*).

After a number of *spermogonia* have been successively developed and discharged their *spermatia*, the *mycelium*, from which they originated, produces a new globular body formed of densely interwoven filaments, usually in the interior of the substance of the leaf or stem, not immediately beneath the epidermis, and ordinarily colourless. Increasing in size in all directions, this globular body, the *perithecium*, soon presents at its base, *i. e.* the point furthest from the nearest epidermal surface, another body composed of very numerous free-ending filaments enclosed in a cellular membrane, which body rapidly grows up within the perithecium, in the direction of the surface of the leaf or stem. The filaments, at first very delicate, are crowded very close together; and each exhibits in its interior a row of short, colourless, roundish cellules, the uppermost of which is always the largest and the most advanced in development. These cellules are the *spores*, and the filaments in which they are found are the *sporangia* or *thecæ*. The membrane enclosing the *sporangia*, the *peridium* of Persoon, grows *pari passu* with them, and is composed likewise of rows of cells, which stand in a circle around the sporanges, but are firmly connected together side by side by an intercellular substance; this membrane closes in like a bell or vault over the sporanges. By the reciprocal pressure of all parts, the cells of this membrane, at first spherical or ovate, become polygonal. At a certain stage the apex of the perithecium gives way, so that it forms a kind of cup around the membrane enclosing the mass of sporanges arising from the base. The whole structure has by this time come immediately up to the underside of the epidermis, which is next ruptured, and the perithecium and the sporanges are protruded, more or less, according to the habit of the species (Pl. 26. fig. 1 *p, p*). The upper portions of the rows of cells composing the peridial membrane then separate more or less from each other, splitting into lobes, so as to set the sporanges free, and form a kind of cup with toothed margins seated in the expanded perithecium (figs. 6 and 6 *a*).

The *spores*, which are at first delicate cellules, subsequently acquire a tough membrane, increasing considerably in size, so as to distend the parent utricle or sporange,

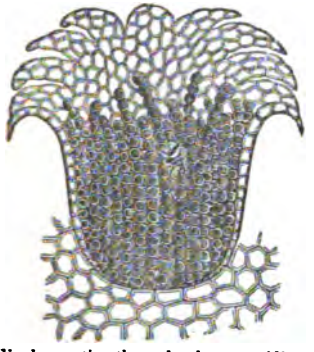
which is ultimately only recognizable where it connects the spores together in a moniliform series. The spores in most cases now acquire a deeper colour (except in *Æ. leuco-*

Æcidium Compositarum, Mart.

Fig. 6.

Peridia in various stages of growth on the surface of a leaf: 30 diam.

Fig. 6 *a*.



Perpendicular section through a burst peridium, showing the sporanges contained in it: 100 diam.

conium), owing to contents chiefly accumulated in the centre. Their membrane is colourless, their form finally irregularly polygonal; and the diameter varies much, even in ripe spores of one and the same species, from 1-1000 to 1-1800 of an inch. The upper spores are often ripe at an epoch when young spores are still in course of production at the lower end of the sporanges; finally, however, the development ceases below, and the tube elongates a little beneath the lowest spore, forming a kind of pedicle or *basidium* to the row. The ripe spores either soon fall apart and fill the cup as a loose powder, along with short incomplete sporanges, or the rows persist even after they are mature, held together probably by a firmer peridial membrane.

The British species of *Æcidium* are numerous; more than thirty are described by Berkeley in the British Flora, many of which are common, especially those of the Mints, the Compositæ (such as the Coltsfoot, &c.), the Barberry, the Gooseberry, Buckthorn, Spurge, Nettle, &c. (*Æ. Compositarum, Menthæ, Berberidis, Grossulariæ, crassum, Euphorbiæ, Urticæ, &c.*).

Oersted and De Bary have made experiments which seem to prove that *Æcidium Berberidis* is a development of *Puccinia graminis*; a full account of which will be found in Cocke and Berkeley, *Fungi*, p. 180.

Bibl. For Species:—*Brit. Flora*, ii. pt. 2. p. 369; Greville, *Sc. Crypt. Flora*, pls. 7, 62, 97, 180, 209; Reess, *Disp. Ured.* 1879.

For Anat. and Physiol.:—Unger, *Exanthème*, pp. 297, 300, t. 3. f. 18, 19, t. 4; Meyen, *Pflanzenpath.* pp. 143, 148-50; Tulasne, *Compt. Rendus*, March 24 and 31, 1851; *Ann. d. Sc. Nat.* sér. 3. t. xv.; *ibid.* sér. 3. t. vii. p. 45; sér. 4. t. ii. pp. 126, 173; Léveillé, *Sur le dév. des* Urédinées, *Ann. des Sc. Nat.* sér. 2. t. xi.; Corda, *Icon. Fung.* iii. t. 3. f. 45; De Bary, *Brandpilze*, Berlin, 1853, p. 55 *et seq.* pls. 5, 6, and 7; Sachs, *Botanik*, 1874, p. 332; Henfrey, *Bot.* (Masters), 1878, p. 460.

ÆGERITA, Persoon.—A genus of Stilbacei (Hyphomycetous Fungi) characterized by short necklace-like threads consisting of irregular spores produced from flexuous, branched, radiating sporophores, forming a subglobose mass. *Æ. candida*, Persoon, grows on damp twigs in marshy places, consisting of scattered white grains about the size of a poppy-seed. *Æ. setosa*, Grev., belongs to the genus *Volutella*.

Bibl. Greville, *Crypt. Fl.* pl. 268. fig. 1; *Ann. N. H.* 1859, iii. 362, pl. ix. f. 7.

ÆGYRIA.—A genus of Infusoria = *Ervilia*, Duj. *Æ. legumen* = *Erv. legumen*, D. Three other species.

Bibl. Claparède and Lachmann, *Infus. &c.* i. p. 288.

ANGSTRŒ'MIA, Br. and Sch.—A genus of Leptotrichaceous Mosses, including many *Dicrana*, and *Ceratodon cylindricus*, Br. and Sch.

Bibl. Müller, *Synops. Musc.* i. p. 426; Wilson, *Bryolog. Brit.* pp. 72, 85.

AËRIAL ROOTS.—A very large proportion of the exotic Orchids are epiphytic plants and produce aërial roots, which absorb moisture from the atmosphere; the same structure occurs in many tropical

Araceæ. The surface of these aërial roots is clothed by a peculiar tissue, formed of cells containing a delicate spiral fibre upon the wall (Pl. 48. fig. 6). The strata of spiral-fibrous cells are sometimes numerous, and they cover up the true epidermis of the root. The growing points of such roots are green; but the spiral-fibrous cells soon come to contain nothing but air, and then assume a silvery-white colour.

ÆTEA, Lamx. See ANGUINARIA.

ÆTHA'LIUM, Link. A genus of Myxomycetes. The common *Æthalium*, *Æ. septicum*, L. (*flavum*, Grev.), occurs frequently on tan in hot-houses, where it is very injurious, from the rapidity of its growth and the abundance of its spores. The ordinary form is yellow; but violet and reddish-brown varieties have been met with. It grows also on mosses in woods. Other species of *Æthalium* have been found growing upon iron, lead, or other mineral substances, sometimes a few hours only after they have been heated, so that the appearance seems quite marvellous. The cream-like matter, of which the part answering to the mycelium or allied production in other Fungi consists, exhibits *Amœba*-like movements.

BIBL. Greville, *Crypt. Flora*, t. 272; Sowerby's *Fungi*, t. 399. fig. 1 (as *Reticularia hortensis*, Bull.), figs. 3 & 4 (as *R. carnosa* and *R. cerea*); Bolton, *Brit. Fungi*, t. 134 (as *Mucor septicus*, L.); Berkeley, *Crypt. Bot.* pp. 236, 339.

AGARICINI.—A family of Basidiomycetous Fungi, belonging to the tribe Hymenomycetes, comprising a great portion of the more important esculent species, characterized by an inferior hymenium spread over distinct gill-like processes, which are often easily divisible into two plates. In a few species the interstices of the gills are traversed by veins so as to produce the semblance of pores. Amongst the more obscure species of the vast genus *Agaricus*, the hymenium is at first superior, but finally becomes inferior by the turning over of the pileus, which is attached at one point only, or by a very short stem.

The hymenium is composed of vertical cells, called *basidia* by Léveillé, *sporophores* by Berkeley. These bodies are elliptical or elongated cells growing out from the surface of the lamellæ, with four slender stalk-like processes at the upper end, each bearing a single spore, which becomes detached when ripe. These basidiospores are observed by means of cross sections of the lamellæ; the sections must be very thin, and require a high power for satisfactory observation. The sections keep tolerably well put up in chloride of calcium or glycerine, and are most instructive when taken from a series of specimens of different ages. See AGARICUS, BASIDIOSPORES, and HYMENOMYCETES. The bodies called *cystidia* or *pollinaria*, are globular or oval cells, found associated with the basidia, containing granular matter exhibiting molecular motion when discharged. These organs have been supposed to represent antheridia, but are more probably paraphyses or abortive basidia.

BIBL. Berkeley *on the Fructif. of Hymenomyc. Fungi*, *Ann. N. Hist.* i. 81; Léveillé, *Sur l' Hymenium des Champignons*, *Ann. Sc. Nat.* 2 sér. viii. 321; Hoffman, *Bot. Zeit.* xiv. p. 137; Cooke, *Illustr. Brit. Fungi*, 1881.

AGA'RICUS, Linn.—A genus of Agaricini (Hymenomycetous Fungi; one of the largest genera in the Vegetable Kingdom, comprising not only a multitude of European species, but many from tropical climates. *Ag. campestris* is the common Mushroom.

See HYMENOMYCETES.

AGATE.—The term agate is specially applied by geologists to the concretions and geodes of chalcedony, formed in the steam-holes and the fissures of volcanic rocks. They consist of crystallized and crystalline varieties of silica, coloured with metallic oxides. Successive and concentric layers of chalcedony, coating the insides of the cavities, have formed solid or hollow nodules, the innermost layers being often colourless or amethystine quartz. In the chalcedony no definite crystallization can be seen, only an obscure fibrous structure at right angles to the planes of deposit, which latter are usually lumpy or mammillary, and often render the mass flaky. In some specimens this fibrous structure becomes more evident in successive layers—minute, close-set, crystalline prisms being visible on fracture; and these may be succeeded by regular quartz-crystals. Those paler varieties of quartz, which consist of concentric layers of radiately grouped crystalline needles, frequently polarize light very beautifully. From the unequal resistance of some of the layers to hydrochloric acid, cut agates may be prepared to take printer's ink and to give impressions on paper. The relatively open prismatic structure of some layers allows agates to be partially coloured by the absorption and carbonization of oil

or honey, or by chemical infiltrations. Nearly all the agates (onyx, sardonyx, &c.) of commerce are thus treated. Carnelian and sard are either burnt or naturally oxidized portions of agate. Sometimes agate contains crystals of calcite imbedded in its substance; and whether coated over, or replaced, these have sometimes given the outlines in the fortification-agates, which are common and elegant objects. Small stalactites, or concentric knobs, of chalcedony enclosed and invested in the cavities, when cut through, give rise to the pretty eye-agates. Some chalcedonies contain delicate branching filaments of delessite and other minerals, and are known as moss-agates and mocha-stones. Great microscopic interest lies in the so-called moss-agates of the south coast of England and the Isle of Wight. These are altered sponge-masses from the chalk and greensand; and, with the chert and flints, have been examined by Bowerbank, who supposed them to have originated in the attraction and solidification, by sponges, of silica dissolved in the water of the ancient ocean. The spicula of sponges are commonly found; also very frequently the fibres, sometimes in a perfect state of preservation, but usually presenting the appearance of having suffered to a great extent from maceration and disruption of their component parts previous to fossilization. Generally the fibres adhere together in confused masses, presenting a moss-like appearance, with here and there one or two in a better state of preservation; and occasionally, near the outer surface of the mass, small portions of the tissue are found quite perfect; in other parts all the intermediate states between perfect preservation and nearly complete decomposition may be observed. The siliceous matter in which these remains are imbedded, usually presents a clear and frequently a crystalline aspect, while the remains of the organized mass are strongly tinted with colours: bright red, brown, and ochre-yellow prevail; but occasionally the colours are milk-white, or bright green. Sometimes the interior of the tubular fibre only is filled with colouring-matter, whilst the sides are semipellucid or of a milky white; in others the whole of the fibres are impregnated with it. Pl. 25. fig. 14 represents sections of a piece of moss-agate (Indian), showing the silicified fibres of sponge *aa*, the gemmules *b*, a separate fibre at *c*, and spicula at *d*. Bowerbank has also described an Alcyonitic structure in a moss-agate.

The supposed vegetable structures in the majority of such agates, described by Turpin, Müller, and others, have been shown by Göppert to be inorganic products, chiefly dendritic deposits of oxide of iron. His essay contains an elaborate history of the strange notions which have at various times been propounded concerning these objects. Gergens has imitated the coloured confervoid appearances by decomposing green vitriol with a weak solution of silicate of soda.

Confervoid bodies, however, have been recognized in the green moss-agate of India; and a living Conferva was actually found in colloid silica by Roberts and Slack. Schaffner has described green confervoid tissue, referable to *Vaucheria*, *Spirogyra*, &c., besides spores, in green Indian stones; and he traced the green colour of the spots in a red opake jasper to *Protococcus*.

There are two distinct points connected with the presence of these supposed organic remains in agate: one is, whether they really are organic, and the other is whether they are related to the formation of the agate, or merely accidentally present. The first is a very difficult point; we have only the microscopic appearance of the bodies under one set of conditions to judge from: this is always very unsatisfactory; many of the appearances most peculiar to organic bodies, especially when the latter are not connected so as to form a tissue, can be closely imitated by crystallization. Still the mass of evidence is decidedly in favour of the appearances really representing portions of sponges and Confervæ.

Bibl. Bowerbank, *Trans. Geol. Soc.* (2) vi. 181; *Ann. N. H.* x. (1842), 9 and 84; *Quart. J. G. S.* iv. 319; Goeppert, *Ratisbon Flora*, 1848, p. 57; Brewster, *Phil. Mag.* (3) xxii. 213; Nöggerath, *Haidinger's Nat. Abhandl.* iii. 93, 147, and *Neues Jahrb. f. Min.* 1847, 473; Gergens, *N. Jahrb. f. M.* 1858, 799; Schaffner, *Flora*, 1859, no. 36; Bischof, *Lehrb. Chem. Geol.* iii. 630; Reusch, *Poggendorf's Ann.* cxxii. 94; Lange, *Halbedelsteine, &c.*, 1868; Hamilton, *Q. J. Geol. Soc.* iv. 209; Billing, *The Science of Gems*, 1867; Zirkel, *Beschaffenh. Min. u. Gest.* 1873, 108; Rupert Jones, *Proc. Geol. Assoc.* iv. 439; Rudler, *Pop. Sci. Rev.* xvi. 1877, 23.

AGATHISTE'GIA, D'Orb.—An order of

Foraminifera in D'Orbigny's classification (1825). It may be said to comprise *Cornuspira*, *Miliola* (subgenera *Uniloculina*, *Biloculina*, *Triloculina*, *Quinqueloculina*, *Spiroloculina*, *Cruciloculina*), *Hauerina*, and *Fabularia*, members of the family Miliolida, as established by Carpenter. The peculiar ball-of-thread-like folding of the segments, whence the name, is constant in the three last-named genera; but in *Cornuspira* it is merged in a discoidal spire at an early stage of growth.

Bibl. D'Orbigny, *Foram. Cuba*, p. 145; *Foram. Canaries*, p. 140; *Foram. Americ.* p. 68; *For. Foss. Vienn.* p. 255; Williamson, *Brit. Foram.* p. 78, &c.; Carpenter, *Int. Foram.* p. 66.

AGA'VE. See Fibrous Structures.

AGLAOPHE'NIA, Lamx (Pfr.).—A genus of Polypi, of the family Plumulariidæ. It consists of *Plumularia cristata*, *myriophyllum*, and *pennatula* (Johnston). See Plumularia.

Bibl. Hincks, *Brit. Hydr. Zooph.* p. 284, pls. 63 & 64.

AGLAOS'PORA, De Notaris.—A genus proposed for *Sphæria profusa*, on account of the asci containing only 4 sporidia; but Tulasne has extended it to some species with eight sporidia, on account of the relation of the pycnidia to the perithecia. The brown spores of *A. profusa*, which is not uncommon on *Robinia pseudacacia*, are beautiful microscopic objects.

Bibl. Tulasne, *Sel. Fung. Carp.* ii. p. 158.

AGO'NIUM, Œrst.—A genus of Confervoid Algæ, fam. Oscillatoriaceæ.

Char. Filaments very slender, rigid, flexuous, tufted, jointed; a single sporidium in each joint.

A. centrale (Pl. 3. fig. 1). Marine; 3–5‴ long; attached to stones.

Bibl. Rabenhorst, *Alg.* ii. 160.

AG'RION.—A genus of Neuropterous Insects. See Libellulidæ.

AGY'RIUM, Fr.—A genus of Lichenaceous Lichens, tribe Graphidei.

1 sp., *A. rufum*. Thallus forming whitish spots; apothecia bright red. On old posts.

Bibl. Leighton, *Lich. Fl.*, p. 392.

AINAC'TIS, Kützing.—A genus of Oscillatoriaceous plants growing on stones in alpine streams. The two known species have been found in Britain.

A. alpina. Fronds from 1-12 to 1-2″ in diameter, often confluent, formed of repeatedly dichotomous filaments, dark olive green, containing separate particles of carbonate of lime. Hassall, *Brit. Fr. Algæ*, lxv. 1. 4; Kutz. *Tab. Phyc.* vol. ii. pl. 63. 1; *Zonotrichia hæmatites*, Rabenhorst, *Alg.* ii. 212.

A. calcarea, Kütz. Fronds 1-4 to 1-2″ in diameter, orbicular, convex, ultimately confluent, sometimes greenish, often dark chestnut, composed of dichotomous filaments, at length incrusted continuously with carbonate of lime. Kützing, *l. c.* pl. 63. 2; *Z. calc.* Rab.; *Lithonema calcaria*, Hassall, tab. lxv. fig. 2.

Kützing states that the gelatinous sheaths of the filaments of *A. alpina* have a spiral-fibrous structure. See Spiral Structures.

AIR.—It need scarcely be remarked that the air consists essentially of a mixture of two gases, oxygen and nitrogen, in the proportion by volume of about 21 parts of the former to 79 of the latter, with variable quantities of gaseous carbonic acid (about 1-2000th) and aqueous vapour. As the component molecules of gases are invisible with any powers of the microscope, the air possesses no microscopic characters. In two respects, however, the study of the air is of great importance:—1st, in regard to the optical appearances produced by the passage of light through it when contained in bodies submitted to microscopic examination; and 2ndly, in regard to the particles which are always, in greater or less numbers, suspended in it.

In microscopic investigations, we meet with air either existing in cells or cavities in various tissues, or in the form of bubbles, confined by the liquid in which the objects are usually immersed. When surrounded and confined by liquid, it mostly assumes a spherical form, in accordance with the law of hydrostatics, that the pressure of fluids is equal in all directions; sometimes the spherical form is exchanged for that of a compressed or oblong spheroid, the result of the pressure of the glass slip covering the object. When confined in cells or cavities, it assumes the form of these. It is in general easily recognized by transmitted light from the smooth and even darkness or shading given to its margins, whilst in the centre it appears luminous and clear. Sometimes the dark margins of air-bubbles have a pale purplish-yellow, blue or greenish tinge. By reflected light, of course, no darkness is produced, but it then appears vitreous and shining, in consequence of the re-

flection taking place from its surface. So long as air-bubbles or confined portions of air are large, the optical appearances above described are sufficiently characteristic; although should any doubt exist as to the nature of a supposed accumulation of air, the latter must be displaced, either by pressure between two slips of glass, or by immersing the object in which it exists in some liquid and applying heat. When, however, air is confined within very minute cavities, especially when these possess definite forms, the clear centre is frequently no longer to be detected, the whole appearing perfectly black and solid; and serious errors have arisen from inattention to this circumstance, as explained in the Introduction (p. xxxv).

The corpuscles of dried bone were thus formerly considered solid bodies, as their name implies, and as consisting of calcareous matter, until it was found that they could be filled with a liquid. In all cases, then, where absolute certainty is required of the nature of an apparent air-bubble or accumulation of air, attempts should be made to displace the mass, either by pressure or prolonged immersion in a liquid, especially with the aid of gentle heat.

The appearance presented by air contained in tissues, is easily studied in a dry section of any kind of pith or other vegetable structure, such as elder-pith, rice-paper, or cork; cork is really heavier than water, and owes its lightness to the air it contains. On immersing these in water, this liquid soon enters the lateral cells, but long digestion is required before the internal cells become filled with it and the whole of the air is displaced. Soaking in alcohol before immersion in water greatly facilitates the displacement of the air.

The determination of the actual nature, as regards chemical composition, of air confined in tissues, is a matter of difficulty where the quantities are microscopic. The nitrogen can only be detected by its negative properties to reagents. The presence of oxygen might be determined by moistening a section of any structure with recently boiled distilled water and then placing it in a cell containing a solution of protosulphate of iron, or an alkaline pyrogallate, and immediately sealing the cell with varnish and allowing the action to continue for some time.

For the detection of Carbonic Acid, see that article.

There is yet a source of fallacy in the detection of air imprisoned in structures where these are of a hard resisting nature, as in mineral bodies. An illustration of this, with the method of its avoidance, is given under Topaz, and Rocks.

In regard to the solid particles present in, or subsiding from the air, and forming dust, these consist principally of the spores of fungi, lichens, mosses, and algæ, pollen, the detritus of the soil, fine fragments of vegetable and animal fabrics accidentally separated and diffused during the ordinary operations of every-day life, the dried but not dead bodies of infusoria, crystals, and metallic particles, and the ova of the lower members of the animal kingdom. The kind of bodies present in the air varies according to the locality; thus in cities, the dust consists mostly of fragments of products of manufactures, with the spores of fungi, mixed with particles of carbon or soot, the ova of the lower animal forms being comparatively few and belonging to a limited number of species; whilst in open places in the country, a more ready diffusion of the spores of plants and the ova of animals takes place, and the sources from which fragments of textile fabrics are derived are less numerous.

The inorganic particles deposited from the air, consist of fine grains of sand, wafted from the soil by winds, and rarely fall otherwise than near the currents by which they are borne. They are easily recognized by their angular forms, their resistance to compression, and their not being destroyed or decomposed by exposure to a red heat. Certainty as to their composition can only be obtained by chemical analysis. See Sand.

The organic forms deposited from the air formerly gave rise to much perplexity. It has long been known that when solutions of various organic substances, or liquids containing these matters undergoing spontaneous decomposition, were exposed to the air, the liquids were soon found to teem with life—infusoria and fungi, according to the nature of the decomposing matter, being discovered in them in abundance. It seemed very natural to conclude that these derived their origin from the substances undergoing decay; and it is not to be wondered at, that the fact should have given rise to the conclusion that here was evidence of the spontaneous or equivocal generation of animals.

This theory has now ceased to be acknowledged; and a common source of fallacious reasoning lies in overlooking the fact, that the air contains the germs of numerous organic forms, still capable of resuming their active vitality when they meet with the requisite conditions. Of this we have convincing proof. For, if the liquid containing the decomposing matters be heated to ebullition for some time in a bottle or other vessel, into the cork closing which two bent tubes are inserted, and, after the air has been completely displaced by the vapour, the fresh air admitted be previously passed through red-hot tubes, or Pasteur's filter of cotton-wool, organisms cease to be met with, and the decomposition of the substance and growth of the organisms no longer take place, even in an indefinite period. That the liquid in these cases does not experience alteration rendering it incapable of supporting the life of the animal forms introduced, is shown by subsequently admitting ordinary air, when the organisms appear as rapidly as in fresh liquids.

Vegetable forms are also constantly met with as deposited from the air. In them, the spores are probably alone the bodies by means of which the diffusion of the lower plants by the agency of the air is effected. Minute fungi are frequently found, like the animalcules above alluded to, in various vegetable and animal liquids undergoing fermentation and decomposition. The question of the relation of these fungi to the processes will be found discussed under FERMENTATION and PUTREFACTION; and the various genera and species found in different kinds of liquids are treated of under the heads of these liquids. Fungi and algæ are also met with as parasites and entophytes upon and in living animals: for an account of these, see PARASITES.

The lower forms of fungi are frequently found growing upon surfaces from which they can derive no nourishment, as upon slips of glass, window-panes, &c. In these cases they must derive their nourishment from the atmosphere. When found in these situations, however, they soon cease to grow by subdivision of cells or gemmation, but speedily form spores. The most common ones in these situations are the sugar-fungus—*Penicillium glaucum* and *Aspergillus penicillatus*, *Mucor*, &c.

The method of distinguishing whether any minute particle deposited from the air is of animal or vegetable nature, is described under TISSUES, ANIMAL and VEGETABLE.

Organic bodies derived from the air are sometimes met with in snow and hail. See SNOW and HAIL.

The air has frequently been examined in regard to the presence of animal or vegetable organisms, which might account for the production of epidemic and infectious diseases; but the results obtained in this direction have not been very satisfactory. Yet as, on adopting the principle of Pasteur's filter, and the use of germicides in the treatment of wounds, and in purifying the air when infectious diseases prevail, most decided benefit has been shown to result, the further examination of the air may allow of the detection in it of the germs of disease which have probably been too often passed over as mere granules, globules, &c. of no import. The best plan of making these experiments is to connect a glass tube, twice bent at right angles, with an aspirator: the free end of the tube should be drawn to a fine point; and just above this the tube should be blown into a bulb. The point is then immersed in a small quantity of pure water, and the water allowed to run very slowly from the aspirator. The water is then slowly drawn into the tube, and the air is washed as it passes by the water in the bulb. When a large quantity of air has been washed by the water, the latter is shaken briskly and allowed to run into a clean glass for examination.

Another method consists in closing, by fusion, the end of a glass funnel, filling this with ice, and collecting the drops of water condensed from the air on its ouside, in a receptacle placed beneath. See MICROZYMES and SCHIZOMYCETES.

Pouchet and Maddox have devised other forms of apparatus for this purpose.

The appearances presented by air as existing in cell-cavities is represented in Pl. 47. fig. 23*a*, in the delicate cavities of a hair in Pl. 29. fig. 1; and the lower part of the same figure represents a portion from which the air has been displaced by liquid.

BIBL. Pasteur, *Ann. d. Chim.* 1862, p. 64, & *Sur les corpuscles organisés de l'air*, *Ann. d. Sc. Nat.* (*Zool.*) 1861, xvi. p. 26; Magnin, *Impaludisme*, *&c.*, 1876; Robin, *Micr.* 1877, p. 870; Miquel, *Comptes Rendus*, 1879; Cunningham, *Mic. exam. of air*, *Calcutta*; Tissandier, *Poussières de l'air*; Pouchet, *Aéroscopie*, 1870; Tyndall, *Lect. Lond. Inst.* (*Times*, Dec. 12, 1877), & *Proc. Roy. Soc.*

1878; Beauregard & Galippe, *Guide &c.* 1880, p. 764; Robin, *Micr.* 1877, p. 870.

AIR-BLADDER of Fishes. See SWIMMING BLADDER.

AIR-BUBBLES. See AIR.

AIR-CELLS or Sacs of animals.—These are dilatations or expansions of the air-passages.

In birds, these are membranous cavities communicating with the lungs and distributed through the chest and abdomen. They extend over almost all parts of the body, around the joints of the extremities, into the bones, the quills, and the feathers, and even between the skin and subjacent muscles. During inspiration, the air enters all these cavities.

In insects, the air-cells or sacs consist of dilatations of the tracheæ. See TRACHEÆ.

Their obvious use is either to diminish the specific gravity of the body, or to act as reservoirs of air during the impeded respiration connected with flight.

BIBL. Siebold and Stannius, *Lehrb. d. vergl. Anat.*; Owen, *Hunt. Lect.*; Carpenter, *Compar. Anat.*; Gegenbaur, *Vergl. Anat.* 1878.

AIR-PASSAGES in plants are large intercellular passages occurring especially in the stems of Monocotyledons and in the leaves and stems of aquatic plants. Their form and arrangement are sometimes very regular and elegant, especially when they depend upon a certain regular peculiarity of shape in the cells which form the walls of the passages. Thus cross sections of the common rush are pleasing microscopic objects, exhibiting regular stellate cells, the rays of which are separated by large air-passages, giving the spongy texture to the structure. Large air-passages, communicating with the stomata, are not unfrequently lined by a cuticular layer similar to that found upon the external surface of epidermal cells. In the *Nymphæaceæ* (Water-lily Order) the large air-passages in the floating leaves and the stem have peculiarly developed star-like cells projecting freely into these cavities; these cells are filled with a granular substance very unlike the contents of the large cells of the general parenchyma of the leaf. Their nature and office are yet unknown. The partitions separating the air-cells horizontally in *Limnocharis Plumieri* and *Alisma plantago* form beautiful microscopic objects. The stems of the *Equiseta*, or Horse-tails, present a very regular arrangement of perpendicular air-passages in the thin walls of their hollow stems, seen well in cross sections. See EQUISETACEÆ.

AIR-SACS in Plants.—The genus *Utricularia*, or Bladder-wort, takes its name from a peculiar structure of its leaves. The common species, *U. vulgaris*, L., often found swimming just below the surface of the water, in quiet streams, is provided with a curious floating apparatus, formed by modification of portions of the feathery leaves, consisting of small membranous sacs or pouches, closed by a valve. The opening of the pouch is somewhat funnel-shaped; and the mouth, as also the internal walls of the cavity, is furnished with curious microscopic glandular hairs. Certain of the cells contain a blue-colouring-matter, distinct in its nature from chlorophyll. The valve of the pouch appears to be capable of opening inwards only; so that while it is turgid with sap, in the vigorous periods of life, it is kept closed by the pressure of the air apparently secreted within the pouch; afterwards the tissue loses its tension and the air makes its way out, allowing water to enter, and thus putting an end to the performance of the function of the air-sac.

BIBL. Meyen, *Secretions-Org. d. Pflanzen*, 1837, p. 12, t. 5. figs. 1–6; Göppert, *Bot. Zeit.* 1847, p. 721; Benjamin, *Bot. Zeit.* 1848; 1 *et seq.*; Schleiden, *Princip. of Botany*, Engl. transl. pp. 77–279; Henfrey, *Elem. Course* (Masters), 1878, p. 523; Sachs, *Lehrb. d. Bot.*, 1874, p. 664.

AIR-TUBES of Insects.—These are horny tubes found in some insects which live in water, as the larvæ of many Diptera and some water-bugs (*Nepa, Ranatra*). They are placed either at the first or last abdominal segment. See NEPA, CULEX, INSECTS.

AIR-VESSELS in Insects, see TRACHEÆ. In plants, see SPIRAL STRUCTURES.

ALA'RIA, Greville.—A genus of Laminariaceæ (Fucoid Algæ), distinguished by the superficial fructification, arranged in definite patches on the surface of special fronds, something like the sori of Ferns. The patches consist of sporanges resembling the thecæ of lichens, crowded together and interposed between perpendicular epidermal cells. The sporanges of *A. esculenta* are described by most authors as pyriform *spores* enclosed in a perispore; but they perhaps produce biciliated zoospores like those of *Laminaria*. See LAMINARIA.

BIBL. Harvey, *Brit. Mar. Algæ*, p. 29, pl. 3 A; Greville, *Alg. Brit.* p. 25, pl. 4.

ALBER'TIA.—A genus of Rotatoria. See ALBERTINA.

ALBERTI'NA.—A family of Rotatoria (Duj.).

Char. Body cylindrical, vermiform, rounded in front, with an oblique orifice, from which the ciliated organ, scarcely broader than the body, projects, terminated behind by a short conical tail. Jaws forceps-like, simple or unidentate.

This family contains only a single genus, and this a single species, *A. vermiculus* (Pl. 43. fig. 4), which lives parasitically in the intestines of worms (*Lumbrici*) and slugs (*Limaces*). Length 1-47 to 1-79″.

Within the body are seen ova and young in various stages of development. The ciliated apparatus in front of the mouth is surmounted by a hood-like appendage.

ALBU'MEN (Chemical).—A proximate principle of animal and vegetable bodies, with which we are familiar as occurring in the white of egg. It exists in two states, uncoagulated and coagulated. At a temperature of 160° F. it is reduced from the former into the latter condition. It is reddened by Millon's test; is insoluble in acetic acid; is rendered purple by Pettenkofer's test, but the reaction requires some time for its production. In the coagulated state it is distinguished from fibrine by the action of acetic acid, and by its insolubility under prolonged digestion at a heat of 110° F. with solution of nitrate of potash. When heated with strong muriatic acid, it is coloured purple.

It possesses no microscopic characters; when coagulated, it appears to consist of extremely fine amorphous granules.

ALBUMEN, or PERISPERM (of seeds).—This is a technical term used in Botany to denote the cellular structure which exists in greater or less quantity in all seeds where the development of the embryo is not accompanied by the entire absorption of the nucleus of the ovule. When the embryo does so displace the nucleus, it becomes immediately invested by the seed-coats; in other cases it is found imbedded in a mass of cellular tissue of varying structure, which is the 'albumen.' The structure of albumen corresponds to that of the cotyledons of seeds devoid of albumen, both serving the same office, namely that of reservoir of nutriment for the germinating seed. This nutriment may be laid up in different conditions—namely, in the state of starch, oil, aleurone, or of cellulose, and in the last case in a soft and fleshy, or a hard and horny condition. Combined conditions are often met with in the same structure, as when a fleshy tissue contains starch or oil in the cavities of its cells, &c.

Starchy, mealy, or *farinaceous* albumen constitutes the chief part of the seeds of many plants, especially of those of the Grass-tribe, and is that portion of the corn-grains whence white flour is obtained. Here the cellular tissue is composed of membranous cells densely filled with starch-grains (Pl. 46. fig. 3). The edible portion of the cocoa-nut is the corresponding region of that seed, and affords us a good example of an oily albumen, composed of tolerably thick-walled cells filled with a viscid mucilage, in which numerous oil-globules are suspended. The stone of the Date, the nut of the Areca Palm (Pl. 47. fig. 21), are good examples of a horny albumen, the cells possessing walls of extreme thickness, traversed by pores and formed, like wood-cells, by the deposition of successive layers. In the ripe seed the structure of this horny albumen is generally much disguised, and a section exhibits the appearance of a homogeneous horny substance excavated into irregular cavities. By applying dilute sulphuric or sulpho-chromic acid, the true boundaries of the cells may generally be distinguished, and often even the lamination of the walls (Pl. 47. fig. 22). The substance called Vegetable Ivory is the albumen of the seed of the *Phytelephas* Palm, and is an instance of an extreme degree of development of the cellulose albumen, vying with the hardest woods in the solidity of its cell-walls. A thin section of this albumen, especially if treated with acid, at once reveals the cellular structure of this dense substance (Pl. 47. fig. 23). The true structure may also be detected by the help of polarized light (see POLARIZATION). The cotyledons of many seeds are, as above stated, formed of elementary structures resembling those of albumen. We find them farinaceous, fleshy, or oily, but rarely attaining to a very great degree of solidity in the horny forms. The cotyledons of beans are composed of a fleshy cellular tissue with thick, porous walls, coloured blue by iodine alone (amyloid), while the cavities of the cells are filled with starch-grains. The cotyledons of the almond, nut, &c. are examples of fleshy cells containing abundance of oil-globles.

The albumen of seeds may be formed by the development of the tissue of the nucleus

of the ovule, in which case it is distinguished by some botanists as the *episperm*; generally it is formed from the cell inside the embryo-sac, the latter expanding to displace the nucleus which becomes absorbed; such albumen is called *endosperm*. Some seeds, such as those of the Nymphæaceæ, Piperaceæ and others, have both *endosperm* and *episperm*, *i. e.* albumen formed inside and outside the embryo-sac. The term *perisperm* is often (advantageously) substituted for albumen, which has quite a different signification in physiological chemistry.

The albumen of seeds is examined by means of fine sections. In the horny or bony seeds, the application of solution of potash or nitric acid is very serviceable in ascertaining the true cellular structure.

BIBL. Schleiden and Vögel, Nova Acta, 1838, xix. p. 52 (plates); Sachs, *Botanik*, 1874, p. 681; Henfrey, *Bot.* (Masters), 1878, p. 154.

ALCYONEL'LA.—A genus of fresh-water Polyzoa (Bryozoa), belonging to the order Hippocrepia and family Plumatellidæ.

Char. Tubes branched, adherent to each other by their sides; orifices terminal; ova (statoblasts) presenting an outer ring, but free from spines.

Polypary (polypidom) incrusting, and forming a sponge-like brown or greenish mass, attached to submersed wooden posts &c.

A. stagnorum (*fungosa*), Pl. 41. fig. 3. Polypary indefinite; orifices of tubes entire, and without a furrow. Rare.

A. Benedeni. Polypary indefinite; tubes emarginate at the orifice, and furnished with a longitudinal furrow. Rare.

A. flabellum. Polypary fan-shaped; tubes prostrate, with a furrow. Rare.

BIBL. Johnston, *Brit. Zooph.* p. 391; Allman, *Polyzoa* (Ray Society), p. 86; Nitsche, *Müll. Archiv*, 1868.

ALCYONID'IIDÆ (Halcyonellea, Ehr., Johnston).—A family of marine Polyzoa (Bryozoa) of the order Infundibulata, and suborder Ctenostomata.

Char. Polypary sponge-like, fleshy, of irregular form; cells irregularly arranged, immersed, with a contractile orifice; no external ovarian capsules. Genera:—

Alcyonidium, Lamx. Erect; lobed or simple; cells pentagonal.

Cycloum, Hass. Incrusting, covered with imperforate papillæ; eggs in circular clusters.

Sarcochitum, Hass. Incrusting, covered with perforate prominences in which the cells are immersed; eggs scattered singly throughout the polypidom.

BIBL. See the Genera.

ALCYONID'IUM, Lamx.—A genus of Infundibulate Polyzoa (Bryozoa), of the suborder Ctenostomata, and family Alcyonidiidæ.

Char. Erect, lobed, or simple; cells immersed, pentagonal.

Nine British species; they occur attached to marine objects by a narrow base.

A. gelatinosum. Lobed, lobes subcylindrical, surface smooth; attached by a narrow base. Deep water.

A. hirsutum. Lobed, compressed, surface papillar from partial protrusion of the polype-cells. Common.

A. parasiticum. Incrusting, earthy, surface porous.

BIBL. Johnston, *Brit. Zooph.* p. 358; Gosse, *Mar. Zool.* ii; Hassall, *Ann. N. Hist.* vii. p. 370; Reid, *ibid.* xvi. p. 393; Hincks, *Polyzoa*, 1880, p. 490.

ALCYO'NIUM.—A genus of Cœlenterata or Zoophytes, belonging to the order Anthozoa, and family Alcyonidæ.

Char. Polype-mass lobed or incrusting, spongy, containing scattered calcareous spicula. The skin (ectoderm) coriaceous, marked with stellate spores; interior gelatinous, netted with tubular fibres and perforated with longitudinal canals terminating in the polype-cells, which are subcutaneous and scattered. Polypes exsertile. Marine.

A. digitatum (spicula, Pl. 41. fig. 28). Commonly called 'dead man's toes or fingers,' and cows' paps. Form of polypidom variable, greyish-white or orange-coloured, skin somewhat wrinkled, studded over with stellate pores, even with the surface.

Very common, so that on many parts of the coast scarce a shell or stone can be dredged from the deep that does not serve as a support to one or more specimens.

A. glomeratum. Colour deep red; rare.

BIBL. Johnston, *Brit. Zooph.* p. 174; Gosse, *Mar. Zool.*; Gray, *Ann. N. Hist.* 1869, v. p. 117.

ALDE'RIA, Pritchard. A doubtful genus of animals discovered by Alder.

The body of one species (Pl. 49. fig. 14) consisted of a vase- or cup-form, expanded at the top and furnished with numerous pointed tentacles, abruptly thickened to-

wards the base and forming more than one row. Body attached to a *Sertularia* by a tolerably stout stem.

A second species was rather smaller, body ovate, with a very slender and shortish stem; tentacles capitate, not so numerous as in the first species, and placed in a single row round a narrow disk.

This was also found on a *Sertularia*.

A third (Pl. 49. fig. 15) was found in fresh water. Body pear-shaped or, rather, bell-shaped, with a distinct rim, and a single row of delicate capitate retractile tentacles; stem long and slender. They come nearest to the genus *Acineta*. Similar organisms have been observed by Str. Wright.

Bibl. *Trans. of Tyneside Naturalists' Field Club*, i. p. 365; *Ann. N. Hist.* vii. p. 426; Pritchard's *Inf.* p. 562.

ALECTO, Lamx. (Stomatopora).—A genus of marine Polyzoa, of the suborder Cyclostomata and family Tubuliporidæ.

The species are found upon old shells and stones from deep water.

A. granulata. Cells in one or occasionally two rows, their walls granular.

A. major. Cells in more than one or two rows, their walls smooth.

A. dilatans. Branches of polypary dilated at the ends; cells in several rows, their walls granular.

Nine other species.

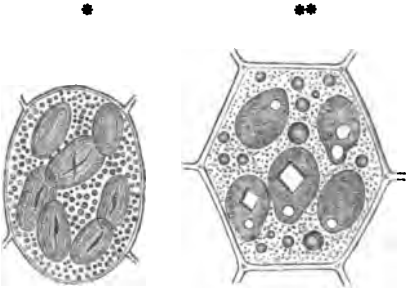
Bibl. Johnston, *Brit. Zooph.* p. 280; Busk, *Cat. of Mar. Polyz.* (Brit. Mus.); Hincks, *Polyzoa*, 1880, p. 424.

ALECTO'RIA, Acharius.—A genus of Lichens, fam. Lichenacei. Six British species; on alpine rocks.

Bibl. Leighton, *Lichen-Flora*, 1879, p. 77.

ALEURONE (Gluten-flour).—This organized cell-substance, like starch, is very generally diffused through the vegetable kingdom, occurring in the endosperm and cotyledons of most seeds. It exists in large quantity in castor-oil and lupine seeds, in nuts, almonds, cocoa, and coffee-beans &c. It was long overlooked, on account of its solubility in water. In starchy seeds it consists of minute granules, of a spherical form, often pitted on the surface, either solid or hollow, and covered by a membrane; while in oily seeds, the grains are larger and more complex. They are insoluble in ether, alcohol, and fixed oils, but soluble in water, dilute acids, and alkalies. They are coloured deep yellow by iodine, and intense red by carmine-solution. Nitrate of mercury renders the interior brick-red, but does not colour the wall. Each granule consists principally of albuminous matter, but also contains gum and sugar. In many oily seeds, as castor-oil, Brazil nuts, &c., the aleurone grains contain a crystalloid and a globoid body. The crystalloids possess angular forms, and so resemble crystals; they are not dissolved by water or acids, but swell in *Liq. Potassæ*, and are coloured yellow by iodine. The globoids are small rounded masses, not crystalline, but composed of phosphate of lime and magnesia: they are soluble in acids, but not in alkalies. Sometimes crystals of oxalate of lime are also met with in the grains. Aleurone is usually colourless, sometimes green, as in pistachio-nuts, yellow in Ailanthus-seeds, or blue. It is most easily examined in a thin section of an almond or castor-oil seed immersed in oil or spirit.

Fig. 6 *b*.



Magnified 400 diameters. Magnified 800 diameters.

* Pisum sativum, the garden pea; showing the small grains of aleurone, and the large starch-grains.

** Cell of Ricinus communis, showing the granular protoplasm with oil-globules, and the ovoid aleurone-grains, containing the round globoids and the angular crystalloids.

The nutritive properties of many seeds, as peas, nuts, almonds, &c., depend to a considerable extent upon the presence of aleurone. And the solubility of aleurone in water is a point of great consideration in regard to the formation of dietary tables. For if, in boiled peas for instance, the nitrogenous proportion is calculated according to that naturally existing, and the liquor be not consumed, the diet will be deficient in that principle to a corresponding degree.

Bibl. Hartig, *Bot. Zeit.* 1857; Wiesner, *Techn. Mikr.* p. 74, 1867; Sachs, *Bot.* p. 52.

ALGÆ, *Sea-weeds &c.*—This class of Thallophytes includes the Sea-weeds and the multifarious green vegetable forms of

simple cellular structure met with in all streams, ditches, ponds, or even the smallest accumulations of fresh water standing for any length of time in the open air, and commonly on walls or the ground in all permanently damp situations. The great variety of conditions of organization, all variations as it were on the theme of the simple vegetable cell, produced by change of form, number, and arrangement of this simple element, renders the Algæ peculiarly interesting as objects of microscopic research, even in regard to morphological conditions alone.

This simple condition of the structures is here, as in other cases, accompanied by a delegation of the physiological functions most completely and fully to the individual cells; that is to say, the marked difference of purpose seen in the leaves, stamens, seeds, &c. of the flowering plants is absent here, and the structures carrying on the operations of nutrition and those of reproduction are so commingled, conjoined, and, in some cases, identified, that a knowledge of the microscopic anatomy is indispensable even to the roughest conception of the natural history of these plants. Added to this, we find these plants of such simple structure that we can see through and through them while living in a natural condition, and by means of the microscope penetrate to mysteries of organization either altogether inaccessible, or only to be attained by disturbing and destructive dissection, in the higher forms of vegetation.

This Class comprehends a vast variety of plants, exhibiting a wonderful multiplicity of forms, colours, sizes, and degrees of complexity of structure; but the subdivision of them into three groups, characterized by striking external characters, which are adopted in the classifications of some of the leading Algologists, facilitates the cursory consideration to which we are confined here. These three Orders are the *Red-spored Algæ* (Florideæ or Rhodosporeæ), the *Dark-spored Algæ* (Melanosporeæ or Fucoideæ), and the *Green-spored Algæ* (Confervoideæ, or Chlorosporeæ)—the first two consisting almost exclusively of Seaweeds, the last of marine and more especially of freshwater plants, the majority of which are microscopic when viewed singly.

The Algæ are differently distributed by Thuret, whose researches on their fructification have thrown so much light upon this class, also by Rabenhorst and Sachs, whose views are referred to under the Orders, and Vegetable Kingdom.

Order 1. Florideæ or Rhodosporeæ. Almost all marine plants, with a leaf-like or filamentous rose-red or purple, rarely brown-red or greenish red, thallus. Fructification appearing in three forms:—1. *spores*, contained in external or immersed definite masses, mostly enclosed in conceptacles or cystocarps (*ceramidia*, *coccidia*, *favellidia*, &c.); 2. *tetraspores* or tetragonidia, red or purple, either external or immersed in the frond, rarely contained in proper conceptacles (*stichidia*), each consisting of a transparent membranous sac containing, when ripe, four spores; 3. *antheridia*, pellucid sacs filled with yellow motionless spherical corpuscles, collected in masses in situations corresponding to the spore-fruits. Fertilization is effected through the agency of a style-like filiform process or trichogyne, with which the spermatozoids copulate. The trichogyne is either only the prolongation of the cell in which the spores are produced; or, more generally, it is supported upon small cells, which take no direct part in the formation of the spores. See Florideæ.

Order 2. Fucoideæ or Melanosporeæ. Marine plants with a leaf-like, shrubby, cord-like or filamentous thallus, of olive-green or brown colour. Fructification very varied:—1. in Fucaceæ consisting of monœcious or dioecious conceptacles or oogonia containing *sporanges* and *antheridia*, the *spores* being fertilized by *spermatozoids* after the discharge of both from the parent; 2. in Laminariaceæ and allied orders consisting of definite or indefinite collections of clavate or filiform *sporanges*, producing biciliated *zoospores*, which germinate directly; 3. in Cutleriaceæ of similar *sporanges* producing *zoospores*, together with *antheridia*, like those of Fucaceæ; 4. in Dictyotaceæ presenting three forms resembling those of Florideæ, viz. collections of *tetraspores*, of *sporanges* containing simple *spores*, and of *antheridia*. See Fucoideæ and Phæosporeæ.

Order 3. Chlorosporeæ or Confervoideæ. Plants growing in sea or fresh water, or on damp surfaces, mostly green, with a filamentous, or more rarely a leaf-like, pulverulent or gelatinous thallus; the last two forms essentially microscopic, consisting frequently of definitely arranged groups of distinct cells, either of ordinary structure or with their membrane silicified (Diatomaceæ). The green colouring matter con-

sists simply of chlorophyll in one group, forming the Chlorophyllophyceæ of Rabenhorst, as the Desmideæ, Confervæ, &c. While in the other, it exists combined with Phycocyanine, giving it a bluish tinge; these forming the Phycochromophyceæ of Rabenhorst, the Cyanophyceæ of Sachs, as in the Oscillatoriaceæ, Nostochaceæ, and Rivulariaceæ. Fructification varied in its details, but essentially reducible to three forms:— 1. *resting spores* produced from the cell-contents after fertilization, either by CONJUGATION or impregnation by (2.) *spermatozoids* produced from the contents of other cells; 3. *zoospores*, 2-, 4-, or multi-ciliated active gonidia, discharged from the vegetative cells without impregnation and germinating directly; in some instances these conjugate (CONJUGATION). The simple *vegetative increase* of the Unicellular forms is a process essentially analogous to the cell-division of the filamentous forms, but results necessarily in multiplication of the species. The Volvocineæ are remarkable for their passing the vegetative stage of existence in the form of ciliated zoospores, mostly collected within a gelatinous common envelope, or cœnobium, into a definitely arranged family. See CONFERVOIDEÆ.

Some Algæ have been found fossil. (See AGATE.)

Excluded families of Algæ:—

CRYPTOCOCCEÆ, Kg., containing the genera *Cryptococcus*, Kg., *Ulvina*, Kg., and *Sphærotilus*, Kg.

LEPTOMITEÆ, Kg., containing the genera *Hygrocrocis*, Ag., *Sirocrocis*, Kg., *Leptomitus*, Ag., *Arthromitus*, Leidy, *Cladophytum*, Leidy, *Mycothamnion*, Kg., *Erebonema*, Römer, *Chamænema*, Kg., *Nematococcus*, Kg., *Chioniphe*, Thienemann, *Moulinea*, Ch. Robin, *Enterobryus*, Leidy, *Eccrina*, Leidy.

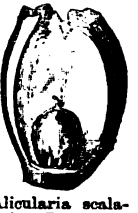
PHÆONEMEÆ, containing the genera *Stereonema*, Kg., *Phœonema*, Kg., *Phœosiphonia*, Kg.

These consist, for the most part, of aquatic states of MUCORINI, or of SCHIZOMYCETES.

BIBL. Harvey, *Brit. Algæ*, 2nd. ed. 1849; *Phycol. Britann.*; C. Agardh, *Syst. Alg.*; J. Agardh, *Species &c. Algar.*; Kützing, *Phycol. generalis*; *Sp. Alg.*; *Tabulæ Phyc.*; *Phycol. Germ.*; Lyngbye, *Hydrophytologia Danica*; Greville, *Algæ Brit.*; Berkeley, *Crypt. Bot.* p. 84; Henfrey, *Elem. Bot.* (Masters); Thuret, *Ann. d. Sc. Nat.* 1855; *& Etudes Phycologiques* (*Anal. d. Algues marines*), 1878; Rabenhorst, *Flora Europ. Algarum*, 1865; Bornet and Thuret, *Ann. d. Sc. Nat.* 1867, vii. p. 166 (*Ann. N. Hist.* 1867, xix. p. 35), *& Notes Algologiques*, 1876; Sachs, *Lehrb. d. Bot.* 1874; Wright, *Spicil. Phycolog.* 1879.

ALICULA'RIA, Corda.— A genus of leafy Liverworts (see JUNGERMANNIEÆ), containing one British species, common on hedge-banks.

Fig. 7.



Alicularia scalaris. Immature sporange in the opened perigone (magnified).

A. scalaris = *Jungermannia scalaris*, Schrad., *J. lanceolata*, Eng. Bot. (fig. 7).

Jungerm. compressa, Hook., which has stipules only on the innovations, is included in this genus by Fries and others.

BIBL. Hooker, *Brit. Jungermanniæ*, pl. 61; Sowerby, *Engl. Bot.* pl. 605.

ALKALOIDS.—The utility of the microscope in distinguishing the more common alkaloids from each other, has been shown in an able paper by Dr. Anderson. The characters consist in the crystalline form of the alkaloids, and in that of their sulphocyanides.

The alkaloids are dissolved in dilute hydrochloric acid, and the dilute solution mixed, on a glass plate, with solution of ammonia of moderate strength if the alkaloid itself is to be examined, or with a strong solution of the sulphocyanide of potassium if the sulphocyanide is required, and at once placed under the microscope. The only precaution requisite is to avoid having the solution too concentrated, as the crystals are then less well-defined than if a dilute solution is employed.

The power employed should be 250 diameters; for if a very high power is used, the form of the crystals is not so readily distinguished.

Atropine is precipitated in the amorphous state by ammonia, and not at all by the sulphocyanide of potassium.

Brucia. A salt of brucia in a sufficiently dilute state, mixed with ammonia, does not give an immediate precipitate; but in the course of a very short time, irregular star-like groups of pointed crystals are observed, as in Pl. 11. fig. 1 *a*. Sulphocyanide of potassium produces a precipitate in tufts of extremely thin and feathery crystals, which either radiate from a centre, or present a sheaf-like appearance. The latter form, however, is much better marked in the crystals deposited after some hours from a

dilute solution, which are still microscopic, although somewhat larger than those represented in the figure (Pl. 11. fig. 1, *b*).

Cinchonine is obtained by precipitation with ammonia in the form of minute granular masses, made up of more or less distinctly acicular crystals, radiating from a centre. It is, however, somewhat difficult to obtain them well-marked; and they not unfrequently appear as a confused mass of granules, in which the radiated structure is very imperfectly seen. They form best when the solutions are rapidly mixed (Pl. 11. fig. 2). With sulphocyanide of potassium, cinchonine gives a precipitate consisting of six-sided plates, together with a variety of irregular crystalline masses, and a few rectangular plates (Pl. 11. fig. 3). When formed by mixing in a test-tube with agitation, and allowing it to stand for some time, the crystals are still microscopic, but much more definite, and sometimes consist almost entirely of isolated six-sided tables, of great regularity. The precipitate dissolves readily in hot water, and is deposited as the solution cools, in irregular plates.

Narcotine is precipitated by ammonia in branched groups of pointed crystals (Pl. 11. fig. 4). In concentrated solutions a precipitate is thrown down by sulphocyanide of potassium, which dissolves readily in hot water, and is again deposited on cooling. Under the microscope it is perfectly amorphous.

Strychnine. The hydrochlorate, treated with ammonia, gives an immediate precipitate, consisting of minute prismatic crystals, all nearly of the same size and very well defined. Most are isolated, but some cross each other at an angle of about 60°. When lying in one position, they exhibit more or less an appearance of a Saint Andrew's cross, with a peculiar arrangement of their terminal facets (Pl. 11. fig. 5.) The sulphocyanide consists of flattened needles, sometimes single, but generally in irregular groups, as in Pl. 11. fig. 6. They are either terminated by a blunt acumination or are truncated. Those precipitated on the large scale present the latter forms.

Morphia. Ammonia does not produce an immediate precipitate in solutions of morphia; but in the course of a longer or shorter period, according to the degree of dilution, crystals form, which gradually increase in size, and possess the form represented in Pl. 11. fig. 7. Salts of morphia are not precipitated by sulphocyanide of potassium, unless the solution is highly concentrated.

Quinine. Its solution gives with ammonia a perfectly amorphous precipitate; with sulphocyanide of potassium small irregular groups of acicular crystals, resembling those produced by strychnia, but longer and more irregular (Pl. 11. fig. 8). When the precipitate is produced in a test-tube, and with a concentrated solution, it falls immediately as a white powder composed of extremely minute needles; but when the solution is dilute, it is deposited after the lapse of twenty-four hours, in crystals from 1-4th to 1-3rd of an inch in length. See QUININE and CRYSTALS.

BIBL. Anderson (T.), *Edin. Mn. J.* viii. p. 570.

ALLAN'TOIN.—A crystalline organic substance found in the liquid of the allantois and in the renal secretion of the calf &c. As artificially prepared, it is one of the products of oxidation of uric acid.

Its crystals form transparent colourless needles and four-sided prisms, with mostly dihedral unequal summits, Pl. 10. fig. 20; not very soluble in either cold or boiling water, more soluble in alcohol, but not at all in ether.

BIBL. See CHEMISTRY.

ALLAN'TOIS.—An oblong or pyriform sac developed during a very early period of embryonic life from near the end of the intestine. Its function is that of a temporary respiratory organ. The capillaries in the allantois of the chick are distributed closely like those of the lungs of the Batrachia.

BIBL. Wagner, *Phys.* by Willis; Müller, by Baly; Carpenter, *Hum. Phys.*; Kirkes' *Phys.*, by Baker.

ALLOMORPHI'NA, Reuss.—One of Reuss's "Cryptostegian" genera of perforate Foraminifera. It has the appearance of an irregular *Miliola*; subtriangular, with the chambers in a triple spire and overlapping so much that only the last three chambers are visible. The aperture is a transverse slit on the inner border of the last chamber. Fossil in the Upper Chalk and Tertiary of Germany.

BIBL. Reuss, *Denks. Akad. Wien*, i. 352; H. B. Brady, *Qu. Mic. Jn.* xix. 67.

ALLOTRICHA, Kent.—A genus of Infusoria, of family Oxytrichina.

BIBL. Kent, *Infusoria*, 1880.

ALO'NA.—A genus of Entomostraca, belonging to the order Cladocera and family Lynceidæ.

The three British species may be thus distinguished:—

1. { Shell reticulated ..... *reticulata**.
   { Shell striated or grooved..... 2.
2. { Anterior margin of shell nearly straight, shell brown..... *quadrangularis*†.
   { Anterior margin of shell convex, shell colourless ... . *ovata*.

* Pl. 19. fig. 4. † Pl. 19. fig. 5.

Bibl. Baird, *Brit. Entomost.* p. 131, pl. 16.

ALSOPH'ILA, R. Brown.—A genus of Polypodiaceous Ferns. Exotic (fig. 8).

Fig. 8.

Alsophila excelsa. Pinnule with sori.

Char. Soriglobose, dorsal, on a vein or in the fork of a vein. Receptacle mostly elevated, often villous. Involucre absent. Veins simple or furcate, free.

Arborescent, mostly tropical; species numerous.

Sections of their petioles exhibit fine scalariform ducts, the slits between the fibres forming many perpendicular rows.

Bibl. Hooker & Baker, *Syn. Filic.* p. 31.

ALTERNA'RIA, Nees.—A genus of Torulacei (Coniomycetous Fungi). Microscopic filamentous Fungi, remarkable for their flask-shaped, cellular spores, produced in chains which ultimately break up into the single links (fig. 9).

Fig. 9.

Alternaria tenuis. Fertile spore-bearing threads (highly magnified).

A. tenuis grows parasitically upon other filamentous Fungi, and on decaying gourds, and is common about Berlin, Prague, and other places. Corda made the ripe spores germinate on *Cladosporium herbarum* kept moist. They usually first protruded a filament from the neck or attenuated projection, and afterwards others from the cells at the sides and opposite end of the spore. These filaments became branched.

The Messrs. Tulasne have shown that *Alternaria tenuis* is merely a state of the common *Sphæria herbarum*.

Bibl. Corda, *Ic. Fung.* iii. p. 5, pl. 1. fig. 16; *Prachtfl. europ. Schimmelbild.* p. 13; Tulasne, *Fung. Carpologia*, ii. pl. 32.

ALTERNATION OF GENERATIONS. See Generations.

ALTEUTHA, Baird (*Peltidium*, Brady).—A genus of marine Entomostraca, of the order Copepoda, and family Cyclopidæ.

A. depressa (Pl. 19. fig. 3). Eye red. Found in Berwick Bay, but not common.

A. interrupta, common; *A. crenatula.*

Bibl. Baird, *Brit. Entom.* p. 216; Brady, *Copepoda* (*Ray Soc.*), ii. p. 158.

AL'TICA. See Haltica.

ALU'CITA.—A genus of Lepidopterous insects, of the family Alucitidæ.

The species are remarkable from having the wings divided into six lobes or rays which are fringed with long narrow scales resembling hairs, giving them a beautiful feathery appearance. They are not uncommon in gardens, and sometimes enter outhouses.

The species of *Pterophorus* exhibit the same structure, except that the anterior wings have two, and the posterior three lobes.

Bibl. See Insects (Wings).

ALUM.—This well-known substance consists chemically of potash and alumina, with sulphuric acid and water. Its crystals belong to the regular cubic or tesseral system, and usually assume the octahedral form. When dissolved in boiling water with slaked lime, it crystallizes in cubes. The term alum has recently been extended to those compounds in which the potash is replaced by other bases; thus we have ammonia-alum, chrome-alum, &c. The crystals exert no influence upon polarized light. Common alum possesses but little microscopic interest. Its solution is used in some of the preservative liquids.

ALVEOLINA, D'Orb.—A genus of Foraminifera Imperforata, of the family Miliolida (Carpenter), nearly allied to *Orbiculina*, but elongated in the direction of the axis; *Orbiculina* being greatly compressed in this direction. *Alveolina rotella* (D'Orb., sp.), however, is nautiloid; *Al. melo*, var. *α*, Ficht. and Moll, is oblately spheroidal; var. *β*, prolately spheroidal; *Al. ovoidea*, D'Orb., elongate-oval; *Al. sabulosa*, Montft., fusiform; and *Al. elongata*, D'Orb., is subcylindrical.

A. fusiformis (pl. 23. fig. 15); *A. rotella* (pl. 23. fig. 16).

Bibl. Carpenter, *Phil. Trans.* 1856, p. 552; *Foram.* p. 99; Parker and Jones, *Ann. Nat. Hist.* ser. 3. viii. p. 161.

AL'YCUS, Koch.—A genus of Acarina, fam. Trombidina.

A. roseus. Body papillose.

BIBL. Koch, *Uebersicht*, &c.; Murray, *Ec. Entom.* p. 150 (fig.).

ALYSCUM, Duj.—A genus of Infusoria, of the family Enchelia, Duj.

Al. saltans (Pl. 30. fig. 8). Colourless, with faint longitudinal furrows; movement abruptly jerking; length 1-1260 to 1-1000″.

Found in infusion of hay, and river-water, which have been kept.

Dujardin remarks that it differs from *Enchelys nodulosa*, Duj. (*Pantotricum Enchelys*, Ehr.), only in the presence of the retractile cilia.

BIBL. Dujardin, *Infus.* p. 391.

ALYS'SUM, Linn.—A genus of Cruciferæ (Flowering Plants), possessing elegant stellate hairs. See HAIRS of plants.

AMÆRÆ'CIUM, or AMAROU'CIUM, M.-Edw.—A genus of Mollusca, of the order Tunicata, and family Botryllidæ.

Four British species—*proliferum* (Pl. 18. fig. 10), *Nordmanni*, *Argus*, and *albicans*.

BIBL. M.-Edwards, *Mém. s. les Ascid. Comp.*; Forbes and Hanley, *Brit. Mollusca*, i. 15; Gosse, *Mar. Zool.* ii. 33.

AMA'THIA, Lamx. See SERIALARIA.

AMBER.—This substance, found as a mineral, but strongly resembling in appearance various gum-resins, is the fossil resin of one or more Coniferous trees belonging to a vegetation now extinct. It is found in drops, lamellæ, and stick-shaped pieces, the form and condition depending probably on the mode and situation of its exudation from the trees. In many instances the fragments of amber contain well-preserved remains of the animals and plants which lived at the period of its formation, these having been enclosed by the fluid resin as it escaped from the tree, in a manner which may be exactly compared with our mode of preserving microscopic objects in Canada balsam. Numerous insects, Arachnida, and other animals, with leaves, twigs, fruits, even flowers of plants, have been described and referred satisfactorily to their systematic position; and the aid of the microscope has been largely called in for this purpose, since the elementary structures are in many cases perfectly preserved. The tissue of fragments of Coniferous wood, the stomata of leaves, and glandular and other hairs have been recognized; and besides the larger Cryptogams, Mosses, Jungermanniæ, &c., peculiar microscopic Fungi and Diatomaceæ have been preserved in a perfectly distinct condition.

Some of the pieces are cloudy or opaque, from the presence of numerous minute cavities, varying in diameter from 1-1000″ to 1-100,000″ (Sorby). Some of these contain gas, some liquid, and others both.

The structure of the wood of the Amber-fir, *Pinites succinifer*, Göpp., approaches closely that of our *Pinus Abies* and *P. Picea*, differing scarcely in any respect but in the smaller number of the bordered pores, which are of slightly different form.

Two microscopic Fungi preserved in amber have been described and figured by Berkeley: *Penicillium curtipes*, and *Brachycladium Thomasinum*, a form approaching *Corethropis* of Corda. A third form, described at the same time as *Streptothrix spirulis*, he now considers to be an appearance produced by enclosed bubbles of air.

Ehrenberg detected Diatomaceæ in amber, namely, *Amphora gracilis*, *Cocconeis borealis*, *Cocconema Cistula*, *Fragilaria capucina*, *Navicula affinis*, *N. Amphioxys*, *N. Bacillum*, *Pinnularia capitata*, and *P. Gastrum*.

BIBL. Göppert and Berendt, *Regensburg Flora*, vol. xxviii. p. 545, 1845; Ehrenberg, *Ber. Berl. Ak.* 1848, p. 17; Berkeley, *Moulds in Amber*, *Ann. N. Hist.* 2nd ser. vol. ii. p. 380, tab. xi., xii.; Idem, *Crypt. Bot.* p. 303; Sorby and Butler, *Mn. Mic. Jn.* xvi. p. 225, 1876.

AMBLY'ODON, Pal. de Beauv.—A genus of Funariaceæ (Acrocarpous Mosses). The only species, *A.* (*Bryum*) *dealbatum*, is rare in Britain.

BIBL. Müller, *Syn. Musc.* i. p. 127; Wilson, *Bryol. Brit.* p. 267.

AMBLYOM'MA, Koch.—A genus of Acarina (Arachnida), fam. Ixodea.

Infests cattle, &c. South America, and Sandwich Islands.

BIBL. Koch, *Arachnid.*; Murray, *Ec. Ent.* p. 201 (fig.).

AMBLY'OPHIS, Ehr.—A genus of Infusoria, of the family Astasiæa.

Char. Unattached; a single (red) eye-speck; a simple flagelliform filament, no tail. One species.

A. viridis (Pl. 30. fig. 55). Green; length 1-210 to 1-140″.

Anterior end of the body colourless, and cleft so as to represent a two-lipped mouth; nucleus near the middle of the body.

Several authors regard this as a *Euglena*.

BIBL. Ehr. *Infus.* p. 103; Duj. *Infus.* p. 636; Kent, *Inf.* p. 385.

AMBLYSTE'GIUM, Br. and Sch.—A genus of Mosses included under HYPNUM by Müller and Wilson.

AMEI'RA, Boeck.—A genus of Copepoda (Entomostraca).

A. longipes. Marine. North Britain.

Bibl. Boeck, *Overs. Norges Copepoder*, 1864, 49; Brady, *Copepoda* (*Ray Soc.*), ii. 36.

AMI'BA, Duj. See Amœba.

AMMONIA, HYDROCHLORATE OR MURIATE OF.—This salt crystallizes in cubes, octahedra, and trapezohedra. When crystallized rapidly it forms curious feathery aggregations (Pl. 11. fig. 9). The crystals do not polarize light.

AMMONIA, OXALATE OF.—This salt is readily prepared by neutralizing a solution of oxalic acid with ammonia or its carbonate, and evaporating.

It crystallizes in long slender needles, belonging to the right rhombic prismatic system. When mounted in Canada balsam, these form a very beautiful object for the polariscope (Pl. 39. fig. 7).

AMMONIA, OXALURATE OF; formerly known as the lithoxanthate of ammonia.

This salt may be prepared by mixing 1 part of uric acid with 32 parts of water, and heating the mixture in a porcelain capsule until it acquires a boiling temperature. Strong nitric acid, previously diluted with 2 parts of water, is next added in small quantities at a time, until nearly the whole of the uric acid is dissolved. The liquid is then boiled, filtered, mixed with excess of solution of ammonia, and concentrated by evaporation. As it cools, the salt is deposited in needles or warty groups of crystals. These are freed from the mother-liquor by pressure between blotting-paper, dissolved in warm water, and a little solution of ammonia added. On evaporation the pure salt separates.

The oxalurate of ammonia forms one of the most beautiful and interesting substances that can be examined by the polarizing microscope. When a small quantity of its aqueous solution is slowly evaporated on a slide, some of it usually crystallizes in circular crystalloid disks or very flat spheres, consisting of minute needles radiating from a centre and in an intimate state of mechanical adhesion; sometimes the extremities of the needles are seen projecting beyond the circumference of the disks. The latter appear colourless or yellowish by reflected light; pale or dark brown or even black by transmitted light, according to their size and thickness. When immersed in Canada balsam, they become transparent, often nothing more being distinguishable than radiating lines, indicating the needles of which they are composed. But if examined by polarized light and with the analyzer, when these are so arranged that the plane of polarization of the analyzer is at right angles to that of the polarizer (the field being black), the disks present the appearance of beautiful little stars, sometimes almost white, at others splendidly coloured, each being also traversed by a black rectangular cross (Pl. 39. fig. 11).

On rotating the slide, no change is produced. But on rotating the analyzer or polarizer 90°, the arms of the cross appear to rotate, which, as there are no fixed points visible in the disks, gives rise to the appearance of the disks themselves rotating. When the analyzer has been rotated a quarter of a revolution, the former position of the black cross is occupied by a white one, and the colours of the intermediate parts become complementary to (forming white light with) those which they at first possessed, these appearances being alternately reproduced at each quarter revolution.

If a plate of selenite is placed beneath the slide, the beauty of the objects is much augmented (Pl. 39. fig. 12). On some parts of the slide, dendritic aggregations of the needles are seen (Pl. 39. fig. 11 *a*).

Sometimes the colours are disposed in concentric rings; when these are well defined, a concentric arrangement of the groups of needles is distinguishable on examining the disks by common light.

A simple experiment will show the origin of the cross and the colours. If eight crystals of any doubly refracting salt be arranged upon a slide in the directions of equidistant radii of a circle, they may be regarded as forming two crosses, alternating in position. If the slide be placed under the microscope, with the plane of polarization of the polarizer and analyzer at right angles, and the crystals be simultaneously rotated and kept in the same relative position, a point will be reached at which each alternate crystal will become black, the intermediate ones appearing coloured; and on continuing the rotation, the crystals which were at first black will appear coloured, those which were coloured appearing black.

The blackness of the crystals arises from the plane of primitive polarization of the light transmitted by the polarizer being parallel with the optic or neutral axis of the

crystals, consequently there is no double refraction and no interference to produce colour; whilst in the coloured crystals, the optic axis of which does not coincide with the plane of polarization, double refraction and interference ensue, by which the colours are produced. The tint of colour varies according to the thickness of the disks.

See CIRCULAR CRYSTALS and POLARIZATION.

AMMONIA, PURPURATE OF, or Murexide.—Is an artificial product of the decomposition of uric acid. It may be prepared by dissolving uric acid in dilute nitric acid, as directed under AMMONIA, OXALURATE OF. The solution is evaporated until it acquires a tile-red colour; then cooled to exactly 158° Fahr., and dilute solution of ammonia added to it until it is neutralized. Half its bulk of water is then added, and the mixture deposits the salt in crystals as it cools.

The crystals form short, flattened, four-sided prisms (Pl. 11. fig. 10); they are ruby-red by transmitted light, and the two broad surfaces are emerald-green by reflected light. They are also analytic.

BIBL. See CHEMISTRY.

AMMONIA, URATE OF. See URATES.

AMMONIO-CHLORIDE OF PLATINUM. See PLATINUM.

AMŒ'BA, Ehr.—A genus of Rhizopoda, of the order Lobosa, and family Amœbæa.

Char. The same as that of the family; but the pseudopodia of one kind only.

These curious organisms constitute the simplest forms of animal beings; for they consist of a single kind of matter, a simple mass of sarcode. When first placed upon a slide, they represent minute rounded semi-transparent masses; but soon, one or more rounded or pointed lobes, or transparent expansions, are seen to shoot out from the margin. These move almost imperceptibly along the slide, and, becoming fixed to it, slowly draw the mass towards the fixed point. They are usually found to contain within them Infusoria, Diatomaceæ, Desmidiaceæ or other minute Algæ which are supposed to serve as food; these bodies being involved in the same manner as occurs in the case of ACTINOPHRYS, a temporary digestive cavity being thus formed. Sometimes vacuoles or contractile vesicles are seen within them, containing simply the surrounding liquid; these contract occasionally and disappear.

Ehrenberg admitted four species; to these Dujardin added ten, and others have since been added; but the characters cannot be depended upon.

They are found in almost all infusions which have not become putrid; also in the slimy *débris* covering bodies immersed in fresh or salt water; sometimes on moss or earth.

Their size varies from 1-70 to 1-2800″.

Amœba diffluens is represented in the expanded state by Pl. 30. fig. 9 *a*; and when contracted, by fig. 9 *b*; fresh water.

A. princeps. Yellowish white, filled with highly refractive granules; 1-50″ in diam. In pools.

A. blattæ, found in the common cockroach, has the body striated (probably the early stage of a *Gregarina*).

Amœba villosa (Wallich) has one part of the body covered with short processes or villi.

In many *Amœbæ*, when the pseudopodia are expanded, the margin of the body appears very transparent, while the inner portions remain granular; this has been regarded as indicating the existence of an endosarc and an exosarc. But when a drop of *liq. potassæ* is added to an *Amœba*, all is dissolved, except the granular matter of the body, which consists of foreign particles, oil-granules, &c.

Many so-called *Amœbæ* are probably early stages of Fungi, &c.; but in such simple structureless bodies, nothing can be stated certainly, without the use of chemical tests.

Certain *Amœba*-forms, in which no nucleus or vacuoles occur, have been separated by Häckel as MONERA; but since any detached fragment of an *Amœba*, or even of any Rhizopod, will live and form a new being, it is evident that such characters are valueless.

Amœba-like movements of the sarcode or protoplasm are often perceptible in isolated normal and pathological structures—as in the blood-corpuscles, the liver-cells, the corpuscles of dropsical liquids, the embryonal cells of ova, &c.; also in various vegetable cells, the root-cells of *Chara*, *Volvox*, the spores of Algæ, the Myxogastres, &c. *Amœba*-like movements may even occur in dead cells (Lieberkühn).

An *Amœba* with a large cilium and a villous tail has been described by Carter; and a free swimming *Amœba* with a cilium by Tatem.

BIBL. Ehr. *Infus.* 126; Dujardin, *Inf.*

231; Auerbach, Sieb. and Köll. *Zeitsch.* vii. 365; Schultze, *Polythal.*; Carter, *Ann. N. Hist.* 1856 and 1864; Wallich, *ibid.* 1863, p. 198; Bronn, *Thier-Reich*, 1880; Perty, *Z. Kenntn.* p. 188; Tatem, *Mn. Mic. Jn.* i. p. 352; Lieberkühn, *Ann. N. Hist.* 1870, vi. p. 497; Greeff, *Arch. f. mik. An.* ii., & x. 1873, p. 51.

AMŒBÆ'A, Ehr.—A family of Rhizopoda, of the order Lobosa.

Char. Animals shell-less, composed of a glutinous substance, without integument or internal structure, constantly changing form by the protrusion and retraction of parts of the body, whence result variable expansions; movement slow.

They are propagated by spontaneous fission. When cut or torn, each segment contracts upon itself and forms a new being. Spermatozoa have been stated to be formed from the nucleus, and ova formed from the sarcode, by Carter in *Amœba*; Greeff also describes spermatozoa, but these are doubtful.

Gen.: *Amœba.* Pseudopodia of one kind.

Podostoma. Pseudopodia of two kinds,—one large and for locomotion, the other forming a proboscis, and serving for nutrition.

Petalopus. Pseudopodia cylindrical, expanding at the ends into thin plates.

AMPELOM'YCES, Ces. See OIDIUM.

AMPHIBLES'TRA, Presl.—A genus of Polypodiaceous Ferns; now referred to *Dictyozyphium* and *Pteris*.—Exotic.

AMPHICAM'PA, Ehr.—A doubtful genus of Fossil Diatomaceæ.

A. Eruca (Pl. 18. fig. 11).

A. mirabilis (Pl. 18. fig. 12).

Fossil at Tisar, Mexico.

BIBL. Ehrenberg, *Ber. d. Berl. Ak.* 1855, 86; and *Mikrog.*

AMPHIDIN'IUM, Cl. and L.—A genus of cilio-flagellate Infusoria.

A. operculatum (Pl. 53. fig. 2). Marine, Norway.

BIBL. Cl. and Lachm. *Infus.* p. 410; Kent, *Inf.* p. 461.

AMPHID'IUM, Nees.—A genus of Mosses, included under ZYGODON.

AMPHILEP'TUS.—A genus of Infusoria, of the family Colpodea (Ehr.).

Eye-spot wanting; no tongue-like process; proboscis and tail present.

The so-called proboscis resembles in appearance a neck. The mouth is situated beneath the junction of the proboscis and the body.

Dujardin gives the following characters, placing the genus among his Paramecina. Body elongated, fusiform or lanceolate, narrowed at each end, or at least at the anterior extremity, and furnished with an oblique lateral mouth.

These animals are usually found in clear marsh water, and in streams, between aquatic plants. They are all furnished with cilia but one; in some these are arranged in longitudinal rows. Species:—

Amphileptus anser, E. (*Dileptus anser*, D.). Colourless; length 1-120″. Proboscis obtuse, as long as the body.

A. margaritifer, E. and D. Colourless; 1-72″. Proboscis acute, as long as the body.

A. moniliger, E. and D. Colourless; proboscis short; nucleus moniliform; 1-72 to 1-96″.

A. viridis, E. and D. Green; 1-120 to 1-46″.

A. fasciola, E. and D. Colourless; linear-lanceolate; 1-720 to 1-144″ (Pl. 30. f. 10 *a*, from above; *b*, side view).

A. meleagris (*Loxophyllum meleagris*, D.). Colourless; 1-72″ (Pl. 31. f. 42 *a*; *b*, anterior portion in side view).

A. longicollis, E. Colourless; rounded behind, tapering in front; 1-120 to 1-96″.

A. papillosus, E. Yellowish brown; body covered with papillæ; 1-600 to 1-480″.

A. vorax, D. (*Trachelius vorax*, E.). Colourless.

A. ovum, D. (*Trachelius ovum*, E.). Colourless.

Claparède and Lachmann describe other species.

See TRACHELINA.

BIBL. Ehr. *Infusionsth.* p. 354; Dujardin, *Infus.* p. 483; Claparède and Lachmann, *Infus.* p. 349; Kent, *Infus.* p. 523.

AMPHILO'MA (Fr.), Nyl.—A genus of Lichens, fam. Lichenacei.

Char. Thallus white, pulverulent, soft, submembranaceous, containing granula gonima. Hypothallus bluish-black, tomentose.

A. lanuginosum. On shady mossy rocks, frequent.

BIBL. Leighton, *Lich.-Flora*, 1879, p. 156.

AMPHIM'ONAS.—A genus of Infusoria, of the family Monadina (Duj.).

Found in kept saline solutions and marsh water. Species:—

A. dispar. Colourless; length 1-3860 to 1-2700″ (Pl. 30. fig. 11).

A. caudata (*Bodo saltans*?, Ehr.). Colourless; 1-2180 to 1-1270″.

A. brachiata. Colourless.

Bibl. Dujardin, *Infus.* p. 292.

AMPHIMORPHI'NA, Neugeboren.—One of the dimorphous Nodosarine Foraminifera, in which the older portion has grown on the Frondicularian plan, and the younger chambers are Nodosarian or Dentaline. Tertiary, Germany.

Bibl. *Verhand. Siebenbürg.* 1850.

AMPHIPEN'TAS, Ehr.—A doubtful genus of fossil Diatomaceæ (Cohort Anguliferæ).

Char. Unattached; frustules cubical, solitary, bivalve, and pentagonal.

A. Pentacrinus; diam. 1-240″; Greek marl.

A. alternans (Pl. 25. fig. 11); Cuba.

Bibl. Ehrenb. *Ber. d. Berl. Ak.* 1840 and 1843, *Abhl.* 1841; Kützing, *Bac.* p. 136; Babenhorst, *Alg.* i. p. 319.

AMPHIPLEU'RA, Kütz.—A genus of Diatomaceæ (Cohort Amphipleureæ).

Char. Frustules free, straight or slightly sigmoid; valves lanceolate or linear-lanceolate, with a median longitudinal line which is thickened and expanded longitudinally at each end, but without a median nodule.

The valves appear to resemble those of *Nitzschia* in their inequality; but they are compressed in the opposite direction to those of that genus, and thus the median lines of both valves are visible at once. That the lines seen upon the frustules are the same as the median lines of the separated valves, is evident from their exhibiting the terminal expansions. This view is confirmed by the sides of the frustules being half as broad again as the separate valves.

A. pellucida (Pl. 16. fig. 7*a*, side view of frustule; *b*, of valve). Valves linear-lanceolate; length 1-225″; furnished with longitudinal and transverse striæ, of extreme delicacy, requiring the best object-glasses of large aperture, and the most oblique light, to render them visible. Sollitt estimates them at 125 to 130 in 1-1000″. Nelson at 80 to 1-1000″ longitudinal, and 96 tranverse, (by vertical illumination): *Jn. Mic. Soc.* i. p. 152, 1881). Fresh water: Brit.

A. rigida, K. (*sigmoidea*, Sm.). Marine; valves narrowly linear-lanceolate, slightly sigmoid; length 1-150″ (Pl. 16. fig. 7 *c*, side view); British.

A. Danica, K. Valves lanceolate, truncate; length 1-400″; coast of Denmark.

A. inflexa. Marine; linear, lunate, slightly attenuate at ends, obtuse; length 1-330″; British.

A. Lindheimeri. Larger than *A. pell.* in fr.-wat. torrents, N. Amer. (Grun, *Oestr. Diat.* i. p. 469, fig.).

A. Frauenfeldii. Indian Ocean. Grun, *ut suprà.*

Bibl. Kützing, *Bacill.* p. 103; *Sp. Alg.* p. 88; Smith, *Brit. Diat.* i. p. 45; Rabenhorst, *Flor. Alg.* i. p. 143.

AMPHIPRO'RA, Ehr.—A genus of Diatomaceæ (Cohort Naviculeæ).

Char. Frustules free, solitary, constricted in the middle; valves convex, having a median keel, with a nodule at each end, and either a nodule or stauros in the middle.

Marine, or inhabitants of brackish water.

Frustules sometimes much twisted, occasionally resembling a violin in form, from one half of the frustule being in a longitudinal plane almost at right angles to that of the other. Surface of the valves more or less distinctly marked with transverse striæ, which under high powers and proper manipulation are resolvable into dots, arranged as in Pl. 15. fig. 8. Many species.

A. alata, E. Common (Pl. 16. fig. 8 *a* side view; *b*, front view). Fr. twisted fr. view linear, ends rounded; valves narrowly elliptical.

A. constricta, E. Fr. straight, narrow; valves with a transverse line, ends acute.

Rabenhorst separates the species with a distinctly curved, mostly sigmoid keel, in a genus *Amphicampa.*

Bibl. Ehr. *Abh. Berl. Ak.* 1841, p. 333; Kützing, *Bacill.* p. 107; *Sp. Alg.* p. 93; Smith, *Brit. Diat.* i. p. 43, ii. p. 92; Greville, *Mic. Tr.* 1863, pp. 13, 20; 1865, p. 105; *Ann. N. Hist.* 1865, xvi. p. 5; Gregory, *Diat. of Clyde*, p. 33; Grun, *Verh. Wien*, 1860, p. 569; Donkin, *Qu. Mic. Jn.* 1861, p. 14; Rabenhorst, *Flora Alg.* i. p. 253.

AMPHIS'IA, Kent.—A genus of Infusoria, fam. Oxytrichina.

Bibl. Kent, *Inf.* 1880.

AMPHISO'RUS.—The compound or aged individuals of *Orbitolites orbiculus*, having chambers on both faces of the disk, are grouped by Ehrenberg under this genus of his *Bryozoa polysomatia.*

Bibl. Ehrenberg, *Abh. Berl. Ak.* 1838; Carpenter's *For.* p. 105.

AMPHISTEGI'NA, D'Orb.—One of the high-class genera of *Foraminifera perforata*, of the Nummuline family. It differs from *Nummulina* mainly in not being symmetrical, one face being more conical than the other. On the flatter face the alar flaps of the chambers are as in *Nummulina*; but on the

other they are packed in around the umbo among the chambers, to which they are attached by very narrow necks. The aperture also lies somewhat on this side of the median plane. Living abundantly in some parts of the tropical seas; and found fossil in some Tertiary strata younger than those rich in Nummulites. Recent, South Seas; fossil, Middle Tertiary, Australia, Europe.

Amphistegina Haueri (Pl. 24. fig. 38).

Bibl. D'Orbigny, *For. Foss. Vien.*; Carpenter, *Foram.* p. 241.

AMPHIS'TOMA (*Holostomum, Diplodiscus*).—A genus of Entozoa of the family Trematoda.

Char. Body soft, oval, cylindrical or conical; intestine 2-branched; two pores, one anterior, the other posterior forming a large sucker.

The species are numerous, most common in birds, but sometimes occur in mammalia, reptiles, and fishes; generally inhabiting the alimentary canal; length from 1-10 to 4-5 of an inch.

A. hominis, in man (India); near the ileocolic valve; red; ½" long.

Bibl. Dujardin, *Helm.* p. 327; Diesing, *Syst. Helm.*; *Proc. Asiat. Soc.* 1876; Cobbold, *Paras.* 1879, p. 37 (fig.).

AMPHITET'RAS, Ehr.—A genus of Diatomaceæ (Cohort Anguliferæ).

Char. Side view of the frustules rectangular, the angles sometimes produced; valves covered with depressions, which are readily seen under a low power.

This genus approaches *Isthmia* and *Biddulphia*, from which it differs in its rectangular and not compressed figure.

A. antediluviana (Pl. 16. fig. 9); *a*, frustules united; *b*, side view; *c*, front view; *d*, perspective view. Lateral surfaces of the frustules with concentric radiating depressions, their sides concave. British; marine.

A. adriatica. Depressions concentric and radiating; angles of the frustules obtuse; lateral surfaces of frustules with straight sides; Adriatic sea.

A. parallela. Depressions parallel; in Greek marl.

10 other species.

Bibl. Kützing, *Bacill.* p. 135; *Sp. Alg.* p. 133; Ehrenberg, *Abh. d. Berl. Ak.* 1839, pp. 122, 144; Greville, *Mic. Trans.* 1865, p. 105, 1866, p. 9; Rabenhorst, *Flor. Alg.* i. p. 318.

AM'PHITHRIX, Ktz.—A genus of Rivulariaceous Algæ; consisting of erect, tufted, flagelliform filaments; with crowded fine articulated fibrils at the base. On wet rocks, the sides of aquaria, &c.; fr. water.

A. papillosa (Pl. 3. fig. 4).

Bibl. Rabenhorst, *Alg.* ii. p. 229.

AMPHIZONEL'LA, Greeff.—A genus of Rhizopoda=*Amœba* with a very delicate shell.

3 species; fresh water.

Bibl. Greeff, *Arch. f. mik. An.* 1866, ii. p. 323; Bronn, *Klass.* pl. 1. fig. 7.

AM'PHORA, Ehr.—A genus of Diatomaceæ (Cohort Naviculeæ).

Char. Frustules solitary, free or adherent; valves with a nodule or a stauros at the middle of the margin on the inner side.

The nodules exist on the flat side of the frustules; the frustules are plano-convex; Pl. 16. fig. 10 *a* represents a transverse section; the side view of the frustules can only be seen when these are made to roll over by sliding the glass cover upon the slide with the mounted needle. (Introduction, p. xxiii.)

The valves are furnished with transverse striæ, resolvable into dots, but in some species these are excessively minute.

The species are both marine and aquatic.

A. ovalis, K. Aquatic; frustules turgid, oval, ends rounded or truncate; length 1-400"; common. (Pl. 16. fig. 10, front view; 10 *a* represents a transverse section.)

A. minutissima, S. Aquatic, adherent to other Diatomaceæ; valves with a stauros; length 1-1200".

A. costata, S. Marine; ends beaked; valves longitudinally ribbed; length 1-500".

A. membranacea, S. (Pl. 16. fig. 11); brackish water.

Rabenhorst describes 54 European and 22 other species.

Bibl. Kütz. *Bacill.* p. 107; *Sp. Alg.* p. 93; Smith, *Brit. Diat.* i. p. 19; Rabenhorst, *Flor. Alg.* i. p. 86.

AMPHOROPH'ORA, Buckt.—A genus of Aphidæ.

A. ampullata is very large, green; eyes red, with very long antennæ fixed on the frontal tubercles; cornicles large, dilated in the middle, with black trumpet-shaped orifices. On *Cystopteris montana.*

Bibl. Buckton, *Aphides* (*Ray Soc.*), 1879, i. p. 187.

AMYLOBAC'TER, Trécul.—The organisms to which this name has been applied are obtained by macerating the stems of plants of various families in water. They are round, or oval, often bacillar and capi-

tate; about 1-50,000″ in length (Pl. 53. fig. 5). They are formed within the laticiferous vessels, but also within cells or fibres, and between the cells. They are coloured yellow by iodine, sometimes purple by sulphuric acid. They seem to correspond to amylaceous Bacteria. They sometimes exhibit rapid movements. Their formation within closed spaces has raised the question of spontaneous generation.

Bibl. Trécul, *Compt. rend.* 1865–7–8; Nylander, *Flora*, xxxviii. 522, 1865; Robin, *Micr.* 881; v. Tieghem, *Bull. S. bot. Fr.* xxiv.

AM'YLOID.—This name was given by Schleiden and Vögel to a peculiar modification of vegetable substance met with in the thickening layers of the cell-walls, in the cotyledons of certain Leguminosæ, viz. *Schotia speciosa*, *S. latifolia*, *Hymenæa Courbaril*, *Mucuna urens*, *M. gigantea*, and the tamarind (*Tamarindus indica*); also of the common white Haricot bean. When in a dry condition, it is of a soft horny consistence; when wetted, it softens, becomes gelatinous and transparent; it is soluble in boiling water, strong acids, and in solution of potash, but not in alcohol or ether. It is coloured blue by iodine, like starch, the compound being soluble in water with change to a yellow colour. The 'amorphous starch,' described by Schleiden, in the seeds of *Cardamomum minus*, in the rhizomes of *Carex arenaria* and Sarsaparilla, seems scarcely distinct from amyloid; it forms a thick viscous layer lining the cells. Amyloid forms a transitional substance between starch and bassorin and cellulose, and probably presents modifications approaching more nearly to one or other of them in different plants.

When cellulose is treated with a mixture of 4 parts of sulphuric acid and 1 of water, it swells into a clear jelly, which is at first stiff, but gradually acquires liquidity; alcohol or water throws down from it white flakes of amyloid, which are coloured blue like starch by iodine. It differs, however, from starch in the circumstance that the iodine can be washed out of it, and the blue colour made to disappear by the action of water, which is not the case with starch.

The so-called Amyloid substance of Virchow consists of a nitrogenous matter, closely allied to albumen. It is coloured deep reddish-brown by iodine, the addition of sulphuric acid sometimes producing a bluish-black or violet tint. It occurs in tissues and organs affected with the waxy or lardaceous degeneration, as the small arteries, the liver, the kidneys, the spleen, and the lymphatic glands.

See Cellulose and Starch.

AM'YLUM. See Starch.

AMYMO'NE, Claus.—A genus of Copepoda (Entomostraca).

A. sphærica and *longimana*. In dredgings.

Bibl. Brady, *Copepoda* (*Ray Soc.*), ii. 28.

ANABAI'NA, Bory. See Trichormus.

ANACALYP'TA, Röhl.—A genus of Mosses, made a section of Pottia by Müller.

Bibl. Müller, *Syn. Muscor.* i. p. 547; Wilson, *Bryol. Brit.* p. 97.

ANACH'ARIS, Rich.—A genus of Hydrocharidaceæ (aquatic Monocotyledonous Plants). *A. Alsinastrum*, Bab., which is apparently identical with *Udora canadensis*, a North-American plant, has become widely diffused in Britain during the last few years in ponds and streams. It is of great interest to microscopic observers, on account of the facility with which the Rotation of the cell-contents may be observed in its living tissues. It is commonly cultivated in jars of water for this purpose.

Bibl. Wenham, *Qu. Mic. Jn.* iii. p. 277.

ANAL'GES, Nitzsch.—Agenus of plumicolous Acarina, fam. Sarcoptidæ. In the species, the integument is striated; the 3rd pair of legs very large and long; the abdomen entire.

Five species; on birds.

Bibl. Mégnin, *Parasites*, 1880, p. 149, pl. 6.

ANACYS'TIS, Meneg.—A genus of Palmellaceous Algæ; consisting of very numerous spherical green cells, imbedded in mucus, and enclosed in a lamellar envelope.

A. marginata (Pl. 52. fig. 8*). Found floating in fr. wat. pools, or on other algæ.

A. Grevillei, on dead stalks of asparagus. Other species.

Bibl. Kütz. *Tab. Phycol.* i. pl. 9. figs. 2–4; *Sp. Alg.* p. 209; Berkeley, *Gleanings &c.*; Hassall, *Brit. Alg.* (*Coccochloris*); Rabenhorst, *Fl. Alg.* ii. p. 52.

ANALYTIC CRYSTALS.—A term proposed by Fox Talbot, in 1837, to designate those crystals which possess the power of analyzing polarized light, like the tourmaline. The substances in which this property is best exhibited are the nitrate of potash, the sulphate of chrome and potash dissolved in tartaric acid by heat, boracic acid, the oxalate of chromium and potash, allantoin, hippuric acid, urea, oxalate of urea,

uric acid, &c. They must be immersed in Canada balsam. The crystalline compound of disulphate of quinine with iodine is inferior to none in this power. The phenomena scarcely need description, since analytic crystals merely play the part of a thick plate of tourmaline, or a Nicol's prism: *i. e.* if polarized light be transmitted through them (a polarizer alone being used), in one position they suffer it to pass freely, while if they are rotated 90° they arrest or absorb it entirely, or to a greater or less extent; and if a plate of selenite, or other depolarizer, be placed beneath the slide upon which the crystals are situated (without the analyzer) the lateral surfaces are seen to be coloured, the complementary tints appearing at each quarter rotation.

Of course these crystals will act equally as polarizers and analyzers. Fox Talbot gives the following explanation of the cause of the phenomena in the crystals which he examined. When a beam of polarized light is transmitted very obliquely through a small prism of nitre, its outline generally exhibits two colours instead of one; for while the edge of the prism, which is on that side from which the ray of light comes, is, for instance, red, the opposite edge will appear green. On reversing the polarization of the light, these colours are exchanged. This observation shows why the phenomenon only occurs in crystals possessing strong double refraction, like nitre, in which the refractive indices of the two rays are materially different. When a ray of common light is incident upon such a crystal, and therefore is divided into two rays oppositely polarized, both rays are transmitted through the central parts of the crystal, which are bounded by parallel planes, or by planes approaching to parallelism. But when the bounding planes of the crystal are much inclined to each other, and therefore refract the light in the manner of a prism, the refractive indices of the rays may differ so much, that while one passes freely through such a prism, the other cannot pass at all, but suffers total internal reflection, and is thereby dispersed; just as if the prism had a larger reflecting angle with respect to that ray than to the other. Therefore if two oppositely polarized rays are presented to such a crystal as in our experiment, one will be transmitted and the other not. That this is the true explanation appears from this, that when the oblique planes are well-formed and clearly defined by the microscope, the colour also is accurately limited by the same boundary; so that while this part analyzes the tints of a plate of sulphate of lime, the rest of the crystal is inactive.

That internal reflection and dispersion, however, are not the cause of the separation of the coloured rays, is shown by the fact that those lateral surfaces of crystals which, when viewed through the microscope (with the polarizer and plate of selenite alone), appear of a certain colour, say green, exhibit the complementary tint, red, when viewed with the naked eye from the side of the stage; hence the two coloured rays are separated merely by refraction.

The margins of cavities containing air and air-bubbles, which sometimes exist in the crystals, exhibit the colours in the same manner and from the same cause as the lateral oblique surfaces of the crystals.

Nothing can surpass the curious and beautiful appearance presented by analytic crystals, the delicacy and brilliant transparency of their coloured margins giving them the aspect of figures drawn with coloured ink.

Pl. 11. fig. 11 *a*, *b*, represent two crystals of nitre, viewed with the polarizer but without the analyzer or the plate of selenite; fig. 12 *a*, *b*, represent two crystals as seen when the polarizer and plate of selenite are used, exhibiting the complementary colours; fig. 12 *c* represents an air-bubble enclosed in the crystal. See DICHROISM and POLARIZATION.

BIBL. Brewster, *Phil. Trans.* 1835; Fox Talbot, *ibid.* 1837.

ANARTHROP'ORA, Smitt, = *Lepralia* part.

A. monodon = *Lepr. mon.*; on stones from deep-sea water.

BIBL. Hincks, *Polyzoa*, p. 232.

ANAU'LUS, Ehr.—A genus of Diatomaceæ.

Char. Frustules single, compressed, subquadrate, not furnished with either tubular processes, nodules or apertures, but having lateral constrictions.

In the latter character it resembles *Biddulphia*.

Kützing admits one species:—

A. scalaris, Ehr. (Pl. 18. fig. 7). Valves turgid in the young state, very broad and flat when mature; having 4, 6, 8, or 14 lateral constrictions, which give the front view a ladder-like appearance; marine; diameter 1-470 to 175″. Antarctic Ocean.

A. indicus, Ehr. = *Terpsinoe indica*, Kütz.

BIBL. Ehrenberg, *Ber. d. Berl. Ak.* 1844, p. 197; 1845, p. 301; Kützing, *Sp. Alg.* pp 119, 120.

AN'BURY, or Ambury, popularly club-root or fingers-and-toes, is a disease peculiar to the Brassicaceæ. It consists in the formation of galls or warts, often of large size, on the lower part of the stems and the roots. It has been attributed to various causes: in some instances, the larvæ of a weevil have been found within the galls, to which their origin might fairly be attributed. The Aphidæ have also been supposed to produce these tumours; this Buckton denies. The later researches of Woronin have traced this disease to the agency of an ally of the Myxomycetes, called *Plasmodiophora Brassicæ*.

BIBL. Johnson, *Gardener's Dict.* p. 31; Buckton, *Aphides* (*Ray Soc.*), ii. p. 20; Woronin, *Pringsheim Jahrb.* xi. p. 548 (pls.).

ANCHOREL'LA, Cuvier.—A genus of Crustacea, of the order Siphonostoma.

Char. Body short, produced in front into a kind of neck, which is transversely rugose; arms two, furnished with a sucker or adhesive disk at the end, and confluent throughout their length.

Two British species—

A. uncinata (Pl. 19. fig. 7), milk-white; found on the gills and gill-covers of the cod, haddock, and whiting; length about 1-2".

A. rugosa, found on a species of cod; length about 1-3".

The above characters refer to the female.

BIBL. Baird, *Brit. Entom.* p. 336.

ANCYR'IUM, Werneck. — An obscure genus of Infusoria.

Char. That of an Enterodelous *Bodo*, with a moveable setaceous foot.

6 (?) species.

BIBL. Werneck, *Ber. d. Berl. Ak.* 1841, p. 377.

ANCHYLOS'TOMA, Dubini.—A genus of Nematoid Entozoa.

A. duodenalis = *Dochmius duod.*

A. dysenterica (Pl. 53. fig. 4) is of doubtful position. It is about 1-100" in length; curved and transparent in front, yellow and opake behind, and expanded at the base. It is firmly attached to the mucous membrane in large numbers; and occurs in the dejections of diarrhœa and dysentery in hot climates.

BIBL. Dounon, *Parasites &c.* 1877; Beauregard, *Mic.* 1880, p. 610.

ANCYRO'MONAS, Kent.—A genus of flagellate Infusoria, fam. Monadidæ.

Char. Ovate or elongate, free or adherent; flagellum single, trailing at the end, vibratile elsewhere; a nucleus and vesicle present.

A. sigmoides, among decaying *Fucus*, Jersey; length 1-5000".

BIBL. Kent, *Infus.* p. 247.

ANCYS'TROPUS, Kohl.—A *Pteroptus*, found on Egyptian bats; dull yellow, with blackish markings, legs brown. Murray, *Ec. Ent.* p. 180 (fig.).

ANDRÆ'A, Ehr.—A genus of Mosses. See ANDRÆACEÆ.

ANDRÆA'CEÆ.—A family of Schistocarpous Mosses, characterized especially by

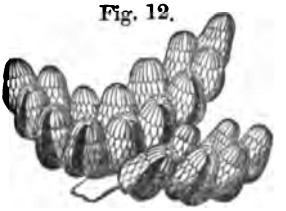
Fig. 10. Fig. 11.

Andræa rupestris.

Fig. 10. A sporange not yet open.
Fig. 11. A sporange burst into four valves, united at their points. Magnified 20 diameters.

the peculiar mode of splitting of the fruit, somewhat analogous to that which is found in *Jungermannia*, the urn-shaped capsule dividing perpendicularly when ripe into four or eight valves, which usually remain attached together at their points (figs. 10 and 11). But the capsules always differ from those of *Jungermannia* in the presence of a columella. The cells of the leaves are parenchymatous, with their walls thickened, and somewhat papillose on the surface. The calyptra at first covers the capsule entirely, then splits off as a mitre-shaped or bell-shaped cup. The archegonia and antheridia are either on the same or distinct plants, and the latter terminal on distinct branches. The few British species are natives of rocky, usually alpine districts, and belong to the genus *Andræa*. In *Acrochisma*, an antarctic genus, the sporange splits only part of the way down.

Fig. 12.



Anemia mandioccana.
Group of sporanges bursting to discharge the spores. Magnified.

BIBL. Wilson, *Bryol. Britann.* p. 11.

ANE'MIA (*Aneimia*), Swartz.—A genus of Schizæaceous Ferns (fig. 12).

Char. Capsules small, very abundant, forming a copiously branched panicle.

Several species; mostly from tropical America.

The fertile fronds, bearing the sporangia, are reduced to mere ribs.

Bibl. Hook. *Sp. Filic.* p. 431.

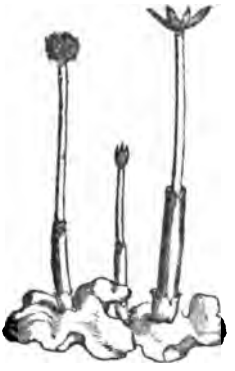
ANEL'LIDA. See Annulata.

ANEU'RA, Dumortier. — A genus of Pelliese (Hepaticæ), growing in wet places, containing 3 British species.

A. pinguis, L. Frond irregularly branched, margins sinuate, calyptra smooth, whole plant brownish-green. = *J. pinguis*, Hooker, Br. Jungerm. t. 46 (fig. 13).

A. multifida, L. Frond bipinnately divided, calyptra tuberculate. = *J. multifida*, Hooker, Br. Jungerm. t. 45 (figs. 14 and 15).

Fig. 13.



Aneura pinguis. Bursting sporanges. Magnified 2 diameters.

Fig. 14.

Fig. 15.

Aneura multifida.

Fig. 14. Portion of a frond with young perichætes, magnified 20 diameters.

Fig. 15. A perichæte, more magnified, cut open to show the archegonia.

A. palmata, Nees.—Frond palmate, calyptra tuberculate, = *J. multifida*, var. *palmata*, Hooker.

Bibl. Hooker, *Brit. Jungermanniæ*; Sachs, *Bot.* 1874, p. 355.

ANGIOP'TERIS, Hoffmann.—A genus of Marattiaceous Ferns. Exotic.

Bibl. Hooker, *Sp. Fil.* p. 440 (pl. 9).

ANGUIL'LULA, Müller (*Rhabditis*, Duj.).—A genus of animals, formerly placed among the Infusoria, but arranged in the order Nematoidea of the class Entozoa by modern zoologists. The popularly known "eels" in vinegar and paste belong to this genus.

Char. Body filiform, narrowed at the ends; mouth terminal, round, naked; anus subterminal; tail of male either naked or furnished with a membrane (winged); a double spiculum; tail of female conical, acute. Mouth succeeded by an oblong cavity (pharynx); stomach top-shaped or spherical, furnished with a kind of dental armature. Tail of the female frequently prolonged into a fine point. Uterus bifid; vulva situated near the posterior third of the body. Oviparous or viviparous.

These animals are especially remarkable and interesting on account of their great tenacity of life; resembling in this respect the Tardigrada and Rotatoria. Thus *Ang. fluviatilis*, when existing in places exposed to the heat of the sun, will dry up and become hard and brittle. But as soon as remoistened by rain, it revives, swells up, becomes soft, takes food and exercises its reproductive functions as before. The same faculty is possessed to an extraordinary degree by *Ang. tritici*, which will revive after having been kept in a dry state for more than five years. Nor are they destroyed by being frozen.

Ang. fluviatilis (?) (*Ang. terrestris*, Duj.) (Pl. 21. fig. 4). White, about 15 times as long as broad; œsophagus fusiform, expanded posteriorly so as to become continuous with the much larger stomach; length of male 1-50 to 1-12".

Found in wet moss and moist earth, whence it gets washed into rivers and ditches; sometimes also in the intestinal canal of snails, frogs, fishes, worms, and insects.

Ang. aceti (Pl. 21. fig. 5). From 30 to 45 times as long as broad, narrowed posteriorly and terminated by a drawn-out point; œsophagus cylindrical; tail conical, pointed; length 1-30 to 1-17".

This species was formerly very common in vinegar, and the "eels in vinegar" were favourite popular microscopic objects. To the freedom of our vinegar from mucilage, and the addition of sulphuric acid allowed by law, must be attributed their comparative rarity in the present day. Still, if to cheap vinegar, in which a few may be perceived by a hand-lens, a little flour be added, they may be bred in swarms.

Ang. tritici (Pl. 21. fig. 6). 20 times as

long as broad in the adult state; length 1-42 to 1-4″; pharynx with an exsertile spear, trilobed at the base.

Found in blighted wheat, and sometimes infesting the young plants, burrowing in the leaf-sheaths, where we have found them reproducing by ova, in great numbers.

Ang. glutinis. About 20 times as long as broad, terminating posteriorly in a fine elongated point; length 1-15″.

Found in sour paste.

Other so-called *Anguillulæ* are found in the same situations as *A. fluviatilis.* See ENOPLIDÆ.

Ang. (*Leptodera*) *stercoralis* is a simple, smooth-bodied nematode 1-625″ long; somewhat narrowed in front, and more so behind; the males and females being nearly equal in size. Found in enormous numbers in the evacuations of patients in Cochin-China.

Ang. (*Lept.*) *intestinalis* is a larger species, sometimes found with the above, but less numerous; length 1-11″, breadth 1-757″.

It is almost impossible to dissect these minute beings in the ordinary manner; the best method of proceeding is to wound the body, and gently press out the contents under water.

BIBL. Dugès, *Ann. Sc. Nat.* 1826, ix.; Bauer, *Phil. Tr.* 1823; Ehrenberg, *Symbol. Phys.*; Dujardin, *Helminthes*; Davaine, *Ann. N. H.* 1856, xviii. p. 268; Bavay, *ibid.* 1877, xix. p. 350; Kühn, Sieb. & Köl-liker's *Zeitsch.* 1857, p. 129; Bastian, *Linn. Tr.* 1865, xxv. 73; Cobbold, *Entozoa*, 1879, p. 236 (figs.).

ANGUILLU'LIDÆ.—A family of nematoid worms.

This family corresponds pretty nearly to the Enoplidæ of Dujardin. The genera have been revised by Bastian in an excellent monograph, in which several new genera and 100 new species are described and figured; to which we must refer those who are specially interested in this curious group.

A small nematoid is very destructive to young cucumber plants, forming cysts in the roots. M. Cornu has recorded a similar disease in the Rubiaceæ. The genus to which these nematoids belong has not been determined.

BIBL. Bastian, *Linn. Tr.* xxv. p. 73, 1865; Cornu, *Compt. rendus*, 1878-9; Beauregard, *Mic.* 1880, p. 604.

ANGUINA'RIA, Lamk. (ÆTEA, Lamx.). —A genus of marine Polyzoa, of the suborder Cheilostomata, and family Eucratiidæ.

Char. Cells tubular, erect, scattered, rising from a creeping fistular fibre adnate to a foreign base; aperture terminal or subterminal. British species:—

A. spatulata. Cells spatulate at the end, curved, ringed.

A. recta. Cells straight.

A. truncata. Cells truncate at the end, surface punctate, not ringed.

Four foreign species.

BIBL. Johnston, *Br. Zooph.* 292; Gosse, *Mar. Zool.* ii. 13; Busk, *Cat. Mar. Polyz.* 31; Hincks, *Polyz.* 1880, p. 2.

ANGUINEL'LA, V. Bened.—A genus of marine Polyzoa, of the suborder Ctenostomata, and family Vesiculariidæ.

A. palmata. Palmately branched, largely composed of mud; tentacles 12; no gizzard; British.

BIBL. Gosse, *Mar. Zool.* ii. 22; Van Beneden, *Bryoz.*; Hincks, *Mar. Polyz.* 1880, p. 539.

ANGULAR APERTURE.—The angular aperture of an object-glass is the angle measured by the arc of a circle, the centre of which is formed by the focal point of the object-glass, the radii being formed by the most extreme lateral rays which the object-glass admits.

Thus let fig. 16 represent a perpendicular section of the lowest combination of an object-glass of small aperture: *a* is the

Fig. 16.

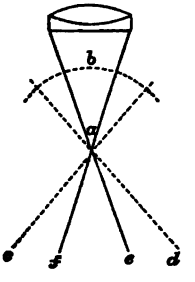


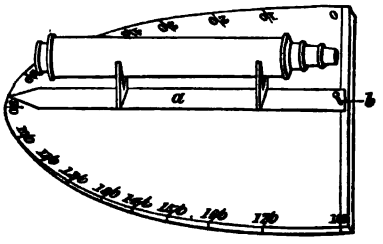
Fig. 17.

angle of aperture; and *f*, *e* are the most oblique rays which the object-glass will admit; the angle is measured by the dotted arc *b*. In the object-glass of larger aperture, fig. 17, the arc *b* which measures the angle is much larger, and the radii representing the extreme lateral rays are much more oblique. Hence it is evident that the object-glass of larger aperture admits all

those rays admitted by that of less aperture, and a certain number of other rays, these being more oblique.

Measurement of the angle of aperture.—It is of the utmost importance to know the angle of aperture of the object-glasses used in investigations; because the appearances presented by objects vary according to the magnitude of this angle, and this variation must always be taken into account in determining the structure of an object from its appearance. A particular piece of apparatus is requisite for this purpose (fig. 18),

Fig. 18.



which may easily be constructed as follows. A rectangular piece of board must be procured, the shortest sides of which are about 2 inches longer than the body of the microscope, and the longer sides twice this length. A small hole must then be made opposite the middle of one of the long sides, at about half an inch from its margin, and from this, as a centre, a semicircle must be traced upon the board, and the semicircular line divided into 180°; the portions outside the semicircle being cut away. The wooden plate of this form is shown in perspective in the woodcut. A flat thin piece of wood (*a*) rather broader than the body of the microscope, a little longer than the radius of the semicircle and pointed at one end, is then placed upon the board in such a manner that the pointed end corresponds with the graduated margin, whilst the other end is transfixed by a pin (*b*) which below is driven into the board. Thus we have a rotating arm or radius of the semicircle, which may be compared to the hand of a watch or clock, the pin forming the centre of rotation. To the upper surface of this arm are glued two thin pieces of wood, excavated in the middle, so as to form supports for the body of the microscope; the excavations should be triangular, the apex being directed downwards.

When used, the object-glass to be tested is screwed to the end of the body next the pin, and so adjusted that its focal point is as nearly as possible perpendicularly over the pin. A lamp is placed 2 or 3 yards from the board and upon exactly the same level as the axis of the body of the microscope, the straight side of the board being next the lamp; and when the arm has been so adjusted that the pointed end is opposite 90°, the lamp is placed so that the flame is seen through the body of the microscope. The eyepiece is next put into the other end. The arm supporting the body of the microscope is then moved on one side, the eyepiece looked through in the usual manner, until the field is seen to be divided into two parts, a dark and a luminous half; the degree which the pointed end of the arm coincides with is then noted, and the arm is moved in the other direction until the division of the field is again seen; the number of degrees included in the arc thus traversed measures the angle of aperture.

This is the old method (Lister's), and that by which object-glasses are still generally measured; so that, for the purposes of comparison, it will be found useful.

But it is considered that it gives an erroneous excess of aperture, from the admission of rays from lateral pencils, which should be excluded. Wenham recommends as a more accurate method, that half the front lens of the object-glass be covered with a piece of tin-foil. The degrees from the half lens are then subtracted from those of the entire lens, and twice the difference represents the aperture.

A very rough method of determining whether an object-glass has a small or large angle of aperture is this: direct the object-glass, with the lower end towards the eye, to the sky at a window; then, keeping the object-glass fixed, move the eye on one side until light is no longer visible in the glass. The extent to which the eye can be moved round, before the light vanishes, indicates the extent of aperture.

Another method is described in Carpenter's 'Microscope,' 1868, p. 172, or Robin, 'Microscope,' 1877, p. 103; also Abbe's "Apertometer," with figs., in the *Jn. Micr. Soc.* 1878, i. p. 19; and H. Smith's "Universal Apertometer," in the *Jn. Micr. Soc.* ii. 1879, p. 775 (fig.).

According to Abbe (Crisp), the aperture of an optical instrument indicates a greater or less capacity for receiving rays from

the object, and transmitting them to the image.

In the microscopic object-glass, the angular aperture is determined by the ratio between its focal length and the diameter of the emergent pencil at the plane of its emergence from the back lens of the combination.

This ratio is expressed for all media and all cases by n sine u; n being the refractive index of the medium, and u the semi-angle of aperture. The values of n sine u, for any particular cases, are the numerical apertures of the object-glasses, so that in dry object-glasses $n=1$; in water-immersion, $n=1{\cdot}33$; and in homogeneous immersion object-glasses, $n=1{\cdot}52$.

F. Crisp gives a Table of the relation of the ordinary expression of the angular aperture to the numerical (*Jn. Mic. Soc.* 1881, i. p. 325). Thus:

180° aperture = 1° num. apert.;

98° = 0°·76; 60° = 0°·50 &c. The corresponding immersion-apertures are also given in this Table.

As an object-glass of large aperture admits a greater number of oblique rays than one of less aperture, the central rays being in nowise interfered with, so the total number of rays admitted is greater, and objects will thereby be more brilliantly illuminated. This is one of the advantages gained by the use of an object-glass of large aperture; and the explanation applies especially to its use in the examination of opaque objects, in regard to which it can be readily understood that a greater number of the rays reflected from all parts of an object being admitted, will render it more luminous and distinct. In this case the same effect would be produced by condensing an additional amount of light upon the object.

There is, however, another far more important use of large angular aperture in an object-glass. It was first found by Goring that the longitudinal and transverse lines upon the scales of Lepidopterous and other insects could be seen under certain object-glasses, but not under others; and that the power of displaying these, or the penetrating power of the object-glass, as it was called, depended upon the magnitude of the angular aperture. The same has since been found the case with the markings upon the valves of the Diatomaceæ, thus:

1. If the valve of a *Pleurosigma angulatum* be examined under an object-glass of 1-4 or 1-8 of an inch focus, and an angular aperture of 60° or 70°, as illuminated by the ordinary light of the mirror, nothing more is seen than the more or less coloured valve with a distinct outline, the central line and the nodules; and no change is produced in the appearances, however intensely the object may be illuminated. But if an object-glass of larger angular aperture be used, a number of fine dark parallel lines are seen traversing the valve. Hence the object-glass of larger aperture possesses a particular power of rendering indications of structure evident, which is not possessed by the one of less aperture.

2. If, in the same experiment, the mirror be brought towards one side of the stage, and the light be then thrown upon the object, the lines will become more distinct if previously visible, and frequently visible when not so before.

3. Placing a stop in the condensing lenses of the achromatic condenser or object-glass will increase the distinctness with which the markings are seen, if already visible, and will frequently render them visible when not so before.

These experiments show, that using an object-glass of large aperture in the examination of an object, bringing the mirror to one side, and placing a central stop in the object-glass or the condenser, or in both, produce the same effects, viz. that of rendering the markings upon an object visible when not so previously, or of rendering them more distinct if previously visible. And it is evident that the alterations of the conditions under which the object is examined in the above experiments, involve simply the viewing of the object when illuminated entirely or more completely by oblique light. For an object-glass of large aperture admits more oblique rays than one of less aperture, the central rays being in nowise interfered with; inclining the mirror to one side, causes all the rays which are reflected from it to become oblique; and the use of central stops excludes all the central rays, so that only the oblique rays are admitted. Hence the visibility or greater distinctness of the markings upon an object depends upon its illumination by oblique light.

Experiment also shows that the degree of obliquity of the light requisite varies with the delicacy or fineness of the markings, being greater as these are more delicate; so that the most delicate markings require the most oblique light which can possibly be

obtained, to render them evident, and the angular aperture of the object-glass must necessarily be proportionately large, otherwise none of these oblique rays could enter it.

In attempting to explain these phenomena, we may take the opportunity of examining somewhat minutely the reason why objects become visible to us under various circumstances.

The ordinary cause of objects becoming visible to us under the microscope, is that a certain number of the rays of light transmitted through or incident upon them or their parts, either become absorbed, refracted or reflected. Hence the parts at which refraction or absorption occurs may become either coloured or dark, whilst those which transmit or reflect the light become luminous. We shall leave the cases of absorption and reflection out of the question at present, and consider only those of refraction.

If the parts which refract the light are large in proportion to the power of the object-glass, and of irregular form, they will refract a certain number of rays, so that these cannot enter the object-glass, and they will hence become dark, and will shadow out, as it were, in the image formed of the object, the structural peculiarities of the object. But if the parts are minute, of a curved form and approximatively symmetrical, their lenticular foci will produce a luminous or dark appearance, according to the relation of the foci to that of the object-glass. Thus, the parts of an object may appear dark and defined, from the refraction of the light from the field of the microscope; also, from the concentration or dispersion of portions of the light by these parts, all the rays being admitted by the object-glass, or entering the field.

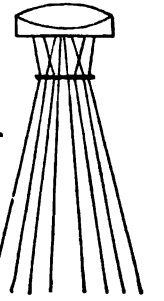
Another condition, rather physiological than optical, is concerned in the question of the distinctness with which an object is seen, nay, even of its absolute invisibility. It consists in the relation which the luminousness or darkness of an object bears to that of the field or background upon which it is apparently situated; and all objects, even those seen with the naked eye, may be regarded as viewed upon a background or field, comparably to an object viewed in the field of the microscope. The familiar instance of the visibility of the stars by day from the bottom of a coal-pit, whilst invisible from the surface of the earth, may serve to illustrate this point. The same phenomenon is constantly met with in microscopic investigations; thus it is well known that parts of structure which are visible most clearly by the light of a lamp in a dark room, cannot be distinguished when the room is illuminated by ordinary daylight; and luminous objects are best seen on a black ground, and dark objects on a light ground.

The refraction of the light out of the field of the microscope or beyond the angle of aperture of the object-glass, is the ordinary cause of the outlines of objects becoming visible; and in these cases an increase of the angular aperture of the object-glass will impair their distinctness, because it will allow of the admission of those rays which would otherwise have been refracted from the field, and the margins will become more luminous and less contrasted with the luminous field. All that is required here is that the object-glass shall be achromatic, and that the marginal rays shall not be decomposed, so that any of the coloured rays should enter the field; in which case, the margins of the objects would appear coloured instead of black, and thus the contrast requisite for distinctness would be lost.

But in certain objects, the irregularities of structure are of such extreme minuteness, or the difference of the refractive power of the various portions of the structure is so slight, that the course of the rays is but little altered by passing through them; and under ordinary illumination, all the rays will enter the object-glass; neither are the lenticular foci sufficient to map out the little light or dark spots in the field of the microscope according to their relation to that of the object-glass.

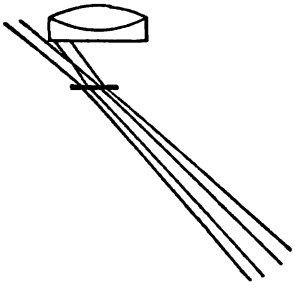
Let us take the instance of an object with minute markings on the surface, as the valve of a *Pleurosigma*. These are so minute, that when the light reflected from the ordinary mirror is used, the rays passing through the depressed and the undepressed portions are not sufficiently refracted to cause either set to be excluded from the object-glass, consequently both sets will enter it (fig. 19). But on transmitting oblique light through the object, as represented in fig. 20, one set of

Fig. 19.



the rays will be refracted so as not to enter the object-glass, whilst the other set will gain admission; thus the two parts, which have differently refracted the rays, will become distinct. If the markings were more

Fig. 20.



delicate, or the difference between the refractive power of the two portions of the valve were less than that represented in fig. 20, both sets would enter the object-glass. But on rendering the light still more oblique, one set would be again excluded, from being refracted out of the field. Hence it is evident why the angular aperture of the object-glass must be larger, as the markings are finer, or the difference between the refractive power of the two portions of tissue is less; because the obliquity of the light requisite to cause the exclusion of one set of the rays will be very great, and the other set will be too oblique to enter the object-glass, unless it be of correspondingly large aperture.

In this way, we were wont to account for the action of large angles of aperture and oblique light in rendering visible the finer markings of objects.

But the entirely new researches of Professor Abbe of Jena, confirmed by others, especially Crisp, Stephenson, and Nägeli and Schwendener, have entirely altered the views upon this subject.

According to Abbe's experiments and mathematical demonstrations, the resolution of the more minute structural peculiarities of objects—those of less size than $\frac{1}{25000}$ of an inch—is produced by the superposition of two images, one of which principally contains the outlines of the object, and is produced according to the ordinary laws of dioptrics; while the other, which yields the finer structural details, arises from the diffraction (or an equivalent deflection produced by refraction or reflection) of the rays within the object, and their interference at the upper focal plane of the object-glass, where they produce distinct interference-images. Unless at least one of the diffracted beams is admitted by the object-glass, together with either another beam or the direct incident pencil, no indication of structure is visible in the microscopical image. And the angle of aperture of an object-glass represents a specific property, entirely distinct from the magnifying and other properties of the object-glass.

If the interference-images are stopped off, or if the angular aperture of the object-glass is too small, the corresponding details disappear entirely from the microscopic images.

Abbe holds also, that structures of this minute kind which an object-glass with direct illumination does not render visible, are also not visible when the object is inclined at any angle whatever to the axis of the microscope; even when, while lying perpendicularly to its axis, they are perfectly resolved by oblique light.

An important result of these views is, that minute structural details are not, as a rule, imaged by the microscope dioptrically, in accordance with the real nature of the object, and cannot be interpreted as morphological but only as physical characters: not as images of material forms, but as signs of material differences in the nature of the particles composing the object, so that nothing more can safely be inferred from the image as presented to the eye than the presence in the object of such structural peculiarities as will produce the particular diffraction-phenomena on which the images depend (Abbe).

In regard to the action of oblique light and angular aperture in relation to colour: neither oblique light nor large angular aperture possesses any power of rendering coloured transparent objects more distinct; and markings, when arising from the presence of pigment, are perfectly visible under an object-glass of small aperture, and the ordinary light of the mirror.

When objects are examined under immersion-lenses, they appear more brilliantly illuminated, especially in regard to the finer details. This is partly to be attributed to the diminution of the loss of light from reflection at the surfaces of the cover and the under surface of the object-glass; but mainly to the circumstance that a larger number of oblique rays are enabled to enter the

object-glass, from the higher refractive power of the immersion-liquid, which produces the effect of an increased angle of aperture in the object-glass. This admission of an increased number of oblique rays, would tend to invalidate the view, that the more delicate structures are rendered visible by the removal from the field of certain oblique rays; but it would favour the rendering of the markings visible by their lenticular foci. According to the diffraction-theory, the admission of a larger number of diffraction-results would explain the increased distinctness resulting from the immersion-arrangements.

Many rather controversial articles on the relation of the dry- to the immersion-apertures will be found in the *M. M. Jn.* from 1872 to 1877.

It was noticed by Goring, that although the lines on the scales of certain insects required an object-glass of comparatively large aperture to show them, yet those existing upon glass micrometers did not so. But this statement is only partially correct; for although the coarser lines upon micrometers are well seen under an object-glass of small aperture with good defining power and direct light, yet the finest lines upon Nobert's test-slide require penetrating power in the object-glass, and oblique light. Thus, R. Beck found that a $\frac{1}{4}$th-in. object-glass of 120° would show all the 20 sets of Nobert's lines; when cut down to 110°, it would not resolve the 20th band; at 100° the 17th was the limit; at 80° the 14th; and at 60° the 10th.

Our space will not permit of entering into further details on this important matter; but we shall refer to it again, in its relation to the markings on the DIATOMACEÆ.

Apertures of Object-glasses.—The following apertures of (dry) object-glasses may be taken to represent those usually met with in good glasses: 2″, 14°; 1″, 25; $\frac{3}{4}$″, 32°; $\frac{1}{2}$″, 40°–80°; $\frac{1}{4}$″, 75°–140°; $\frac{1}{8}$″, 140°; $\frac{1}{12}$″, 145°–170°; $\frac{1}{15}$″, 160°; and $\frac{1}{50}$″, 150°. The apertures of the foreign object-glasses are usually over-estimated by the makers in their price-lists.

The transverse lines seen upon the scales of insects are noticed under SCALES of INSECTS. The structure of the valves of the DIATOMACEÆ is discussed under that head; see also INTRODUCTION, p. xxxix, *l.*

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ANIMALCULE. — A little animal; a term usually applied to the Infusoria, Rotatoria, &c. It was formerly applied also to many of the lower Algæ. The Latin term *animalculum* (plural *animalcula*) is frequently met with.

ANIMAL KINGDOM.—In accordance with our plan, as laid down in the Preface, we give here a tabular view of the animal kingdom, so that the position of the various classes and orders alluded to in various parts of this work may be readily found. Those classes, orders, families, and genera to which particular interest is attached in relation to structure or other qualities, which the microscope is required to investigate, are specially treated of under their respective heads.

Kingdom ANIMA'LIA.

Subkingdom I. VERTEBRA'TA.

Class I. MAMMA'LIA.

Order 1. BI'MANA.
Homo, man.

Order 2. QUADRU'MANA.
Simia, ape; *Cercopithecus*, common monkey; *Semnopithecus*, Indian monkey.

Order 3. CHEIROP'TERA.
Vespertilio, bat.

Order 4. INSECTI'VORA.
Erinaceus, hedgehog; *Talpa*, mole.

Order 5. CARNI'VORA.
Canis, dog and wolf; *Ursus*, bear; *Felis*, lion; *Nasua*, coatimondi.
PINNIPEDIA. *Phoca*, seal.

Order 6. CETA'CEA.
Balæna, whale; *Phocæna*, porpoise.
SIRENIA. *Halicore*, dugong; *Manatus*, manatee.

Order 7. PACHYDER'MATA †.
Equus, horse; *Sus*, hog; *Hippopotamus*; *Choiropotamus*.

PROBOSCIDEA. *Elephas*, elephant.
Order 8. RUMINAN'TIA†.
Bos, ox; *Camelus*, camel; *Cervus*, deer; *Capra*, goat; *Ovis*, sheep.
Order 9. EDENTA'TA (BRUTA).
Dasypus, armadillo; *Bradypus*, sloth.
Order 10. RODEN'TIA.
Cavia, guinea-pig; *Lepus*, hare; *Mus*, mouse and rat; *Sciurus*, squirrel; *Castor*, beaver and musquash; *Chinchilla*.
Order 11. MARSUPIA'LIA.
Macropus, kangaroo; *Didelphys*, opossum.
Order 12. MONOTREM'ATA.
Ornithorhynchus, duck-billed platypus.

†† These two orders form the Class Ungulata of some authors.

Class II. AVES, birds.

a. CARINATÆ.
Order 1. RAPTO'RES; birds of prey.
Aquila, eagle; *Strix*, owl.
Order 2. INSESSO'RES (PASSERES); perchers.
Fringilla, finch; *Hirundo*, swallow; *Turdus*, thrush, blackbird.
Order 3. SCANSO'RES; climbers.
Cuculus, cuckoo; *Psittacus*, parrot.
Order 4. GALLI'NÆ; RASO'RES.
Gallus, fowl; *Columba*, pigeon.
Order 5. GRALLATO'RES; waders.
Grus, crane.
Order 6. NATATO'RES; swimmers.
Larus, gull; *Anas*, duck; *Anser*, goose.
b. RATITÆ.
Order 7. CURSO'RES; runners.
Struthio, ostrich.

Class III. REPTILIA, reptiles.

Order 1. CHELO'NIA.
Testudo, tortoise.
Order 2. SAU'RIA.
Lacerta, lizard.
Order 3. OPHID'IA.
Boa; *Coluber*, snake.
Order 4. CROCODIL'IA.
Crocodilus, crocodile.

Class IV. AMPHIBIA.

Order 1. ANU'RA.
Rana, frog; *Bufo*, toad.
Order 2. URODE'LA.
Triton, water-lizard; *Menopoma*; *Proteus*.

Class V. PISCES, fishes.

Order 1. GANOI'DEA.
Lepidosteus, bony pike; *Sturio*, sturgeon.
Order 2. PLACOI'DEA.
Carcharias, shark; *Raia*, skate.
Order 3. CTENOI'DEA.
Perca, perch.
Order 4. CYCLOI'DEA.
Salmo, salmon; *Clupea*, herring; *Cyprinus*, carp.
Order 5. CYCLOS'TOMI.
Petromyzon, lamprey.
Order 6. LEPTOCAR'DEA.
Amphioxus, lancelet.

Subkingdom II. MOLLUSCA.

Class I. CEPHALOP'ODA.
Sepia, cuttle-fish; *Nautilus*.
Class II. GASTEROP'ODA.
Helix, snail; *Limax*, slug; *Littorina*, periwinkle.
Class III. PTEROP'ODA.
Clio.
Class IV. CONCHIF'ERA (LAMELLIBRANCHIA'TA), shell-fish.
Ostrea, oyster; *Mytilus*, mussel.
Class V. BRACHIOP'ODA.
Terebratula, lamp-shell.
Class VI. TUNICA'TA.
Ascidia, Salpa, Botryllus, Amaroucium.
Class VII. POLYZO'A (BRYOZOA), Seamats, &c.

Subkingdom III. ARTHROP'ODA (*Articulata*).

Class I. CRUSTACEA, crabs, lobster, &c.
Order 1. DECAP'ODA.
Cancer, crab; *Astacus*, lobster and crayfish.
Order 2. STOMAP'ODA.
Squilla.
Order 3. AMPHIP'ODA.
Gammarus, freshwater shrimp.
Order 4. ISOP'ODA.
Oniscus, wood-louse; *Asellus*, water wood-louse; *Limnoria*.
Order 5. PHYLLOP'ODA.
Branchipus, Artemia.
Order 6. CLADOC'ERA.
Daphnia, water-fleas.
Order 7. COPEP'ODA.
Cyclops.
Order 8. OSTRACO'DA.
Cypris.
} Entomostraca.

Order 9. CIRRIPE'DIA (*Cirrhopoda*).
Balanus, acorn-shell; *Lepas*, barnacle.
Order 10. SIPHONOS'TOMA (*Ichthyophthira*); fish-lice.
Order 11. PŒCILOP'ODA.
Limulus, king-crab.

Class II. ARACHNI'DA, spiders.
Order 1. ARANE'IDA.
Aranea, house-spider; *Epeira*, garden-spider.
Order 2. PEDIPAL'PI.
Scorpio, scorpion.
Order 3. SOLIF'UGA.
Galeodes.
Order 4. PSEUDOSCORPIO'NES.
Chelifer.
Order 5. PHALAN'GIDA.
Phalangium, harvest-spinner.
Order 6. ACARI'NA.
Acarus, mites.
Order 7. TARDIG'RADA (*Colopoda*); water-bears.
Order 8. PYCNOGON'IDA (*Polygonopoda*).
Pycnogonum.

Class III. MYRIAP'ODA.
Order 1. CHILOGNA'THA.
Iulus.
Order 2. CHILOP'ODA.
Lithobius.

Class IV. INSECTA, insects.
Order 1. COLEOP'TERA.
Beetles.
Order 2. ORTHOP'TERA.
Blatta, cockroach; *Acheta*, cricket.
Order 3. HEMIP'TERA.
Cimex, bug; *Aphis*; *Aphrophora*, cuckoo-spit.
Order 4. NEUROP'TERA.
Ephemera; *Libellula*, dragon-fly.
Order 5. LEPIDOP'TERA.
Butterflies and moths.
Order 6. HYMENOP'TERA.
Apis, bee; *Vespa*, wasp; *Formica*, ant.
Order 7. DIP'TERA.
Œstrus, bot-fly; *Musca*, house-fly.
Order 8. STREPSIP'TERA, bee-parasites.
Stylops.
Order 9. APHANIP'TERA (*Siphonaptera*; *Suctoria*).
Pulex, flea.
Order 10. ANOPLU'RA.
Pediculus, louse.
Order 11. THYSANU'RA.
Lepisma, *Podura*.

Subkingdom IV. VERMES.

Class I. ANNULA'TA (*Anellida*).
Order 1. SETIG'ERA.
Lumbri'cus, earthworm; *Nais*; *Tu'bifex*; *Aphrodi'ta*.
Order 2. SUCTO'RIA.
Hirudo, leech.
Order 3. TURBELLA'RIA.
Planaria.

Class II. ROTATORIA (*Rotifera*).

Class III. ENTOZO'A.
Order 1. CESTOI'DEA, Tape-worms.
Tænia; *Bothriocephalus*, *Acanthocephalus* (*Cystica*, *Cysticercus*, *Echinococcus*, *Cœnurus*).
Order 2. TREMATO'DA.
Dis'toma, fluke, (*Cercaria*); *Gyrodactylus*.
Order 3. ACANTHOCEPH'ALA.
Echinorhynchus.
Order 4. NEMATOID'EA.
Tricocephalus, *Filaria*, *Ascaris* (*Oxyuris*), *Anguillula*, *Gordius*, *Trichina*.

RADIATA.

Subkingdom V. ECHINODER'MATA.
Class I. A'PODA.
Chirodota.
Class II. PEDICELLA'TA.
Asterias, star-fish; *Echinus*, sea hedgehog; *Ophiocoma*; *Spatangus*.

Subkingdom VI. CŒLENTERA'TA (*Zoophytes*).

Class I. ACTINOZO'A (*Anthozoa*, *Polypi*).
Order 1. ZOANTHA'RIA.
Actinia, sea-anemone; *Sagartia*; *Madrepora*, stone-coral.
Order 2. ALCYONA'RIA.
Alcyonium, *Gorgonia*, sea-fan.

Class II. HYDROMEDU'SÆ (*Hydrozo'a*).
Order 1. DISCOPH'ORA (*Acalephæ*).
Medu'sa, sea-nettle, jelly-fish; *Cyanœa*.
Order 2. HYDROI'DA.
Hydra; *Sertularia*; *Campanularia*.
Order 3. SIPHONOPH'ORA.
Physalia, Portuguese man-of-war.

Class III. CTENOPH'ORA.
Beroë.

Subkingdom VII. PROTOZO'A.

Class I. INFUSOR'IA.

Class II. RHIZOP'ODA.
Order 1. RETICULA'RIA.
Gromia, Foraminifera.
Order 2. RADIOLA'RIA.
Actinophrys, *Acanthometra*; *Polycystina*.
Order 3. LOBO'SA.
Amœba, *Arcella*.
Order 4. GREGARI'NIDA.

Class III. SPONGIDA.

MONERA.

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ANISONE'MA, Duj.—A genus of Infusoria, belonging to the family Thecamonadina (Flagellata, Kent).

Char. Body colourless, oblong, more or less depressed, covered with a resisting tegument, from an aperture in which two filaments emanate—one flagelliform and directed forwards; the other thicker, trailing and retracting the body of the animal; movement slow. 2 species:—

A. acinus (*grande*). Movement directly forwards, colourless; length 1-1280 to 1-810″; fr. wat. among *Confervæ*.

A. sulcata (Pl. 23. f. 12). Movement vacillating in a circle; colourless; fr. wat.; length 1-1100″.

3 other species. Dujardin suggests that the *Bodo grandis* of Ehrenberg is referable to one of these species, as also to the genus *Heteromita*, Duj.

BIBL. Dujardin, *Infus.* p. 345; Kent, *Inf.* p. 434.

ANKISTRODESMUS, Corda (*Raphidium*, Rabenh.).—A genus of Desmidiaceæ.

Char. Cells elongated, attenuated, entire, aggregated into faggot-like bundles.

The cells only differ from those of *Closterium* in their aggregation. Species:—

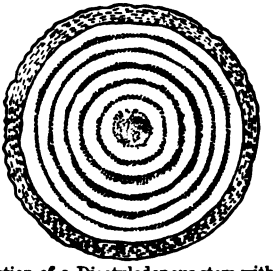
A. falcatus, Corda (*Rhaphidium fasciculatum*, Kütz.). Cells numerous, crescent-shaped: aquatic; length 1-549″, breadth 1-7353″; common. (Pl. 14. fig. 47.)

A. fusiformis, Corda. } Carlsbad.
A. convolutus, Corda. }

BIBL. Ralfs, *Brit. Desmidieæ*, pp. 179 and 222; Corda, *Alman. d. Carlsbad*, 1835, p. 121, 1838, p. 199.

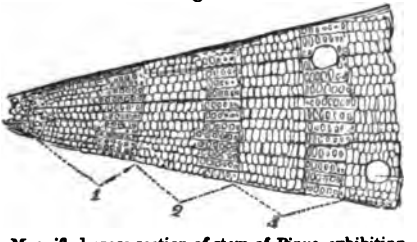
ANNUAL RINGS. — The concentric lines seen in transverse sections of Dicotyledonous stems (fig. 21) generally indicate successive annual additions to the woody structure, and in these cases depend on the difference of the character or condition of the tissues produced at different seasons.

Fig. 21.



Cross section of a Dicotyledonous stem with annual rings.

Fig. 22.



Magnified cross section of stem of *Pinus*, exhibiting parts of three annual rings, 1, 2, 3.

Ordinarily there are a number of ducts grouped near the inner part of each concentric layer of wood, as in the Oak. In the Sumach a layer of cellular tissue occurs at the boundary of each ring. In the Conifers, the markings result from the greater thickness of the secondary deposits on the walls of the cells in the outer part of each layer, no ducts existing in their wood (fig. 22).

It seems that these rings cannot be taken strictly as annual rings in all trees, especially in those of equable climate, since they appear to depend upon external influences affecting the activity of vegetation; and thus, even in temperate climates, a great loss of foliage in the summer, followed by recovery, may produce two rings in one year. In moist tropical climates, where the leaves reappear almost continuously, the rings probably answer to periods of great renewal of foliage.

ANNULA'TA, *Anellida*.—The class of red-blooded worms, &c.

Char. Elongated animals, living in water or moist earth, not parasitically within other animals; body usually ringed or jointed; feet not jointed, and frequently replaced by bristles or retractile setigerous tubercles. Respiration effected either by external branchiæ or by internal vesicles, or by the skin itself. Distinct organs of circulation present, contractile vessels replacing a heart. Nervous system consisting of a single or double ventral cord, furnished with ganglia at intervals, and encircling the œsophagus above.

The *skin* consists of a very delicate structureless and transparent epidermis, beneath which (in *Hæmocharis* (*Piscicola*), *Clepsine*, and *Nephelis*) there is a layer of cells, which, in the adult animals, presents the appearance of a fenestrated membrane (Pl. 49. fig. 16). The cells (Pl. 49. fig. 16 *b*) leave spaces between them which appear like holes; but the addition of acetic acid brings to light in each space a distinct nucleus (Pl. 49. fig. 16 *c*), and in very young animals the clear spaces are distinct cells, distinguishable from the surrounding cells by their size and containing numerous clear vesicles as well as a nucleus. The smaller cells contain a nucleus and numerous nuclear granules. Beneath this cellular layer are numerous large fat-cells, pigment-cells, and connective tissue, the latter consisting of a transparent, homogeneous, semisolid mass. A layer of fine but firm fibres, crossing each obliquely, is said to be sometimes met with beneath the epidermis and forming a corium or true skin.

In the Turbellaria, the outermost cutaneous layer consists of ciliated epithelium. The opalescent and often beautifully coloured skin of many of the Annulata does not generally owe its tints to distinct pigment, but to iridescence produced by the fibres.

The rings of the body are usually furnished with bristles or hairs, sometimes arranged in tufts, at others covering the greater part of the surface of the body.

The bristles are most exquisite objects for microscopic observation, displaying the greatest variety of form, constituting lances, spears, knives, saws, sickles, hooks, &c., of innumerable elegant shapes, often curiously jointed, and usually fashioned out of an elastic material that rivals the clearest glass (Gosse). Sometimes foliaceous appendages cover the body like scales. Most of the Annulata are covered with a kind of mucus, secreted by the cutaneous glands; some live in leathery tubes or sheaths; in others a case is made by the consolidation of the secretion from some part of the skin with fragments of shells, grains of sand, &c.; in others, again, the calcareous tubes appear to be wholly secreted by a portion of the cutaneous surface.

The *muscular system* is usually well developed. The muscular fibres are in some arranged in three layers, an outer consisting of annular, an inner of longitudinal, and an intermediate of oblique fibres; in others there is an outer layer of oblique fibres, an inner of longitudinal, with annular fibres at the two ends of the body. The muscular fibres consist of cylinders, the transverse section of which is rounded (Pl. 49. fig. 17 *a*), flattened or incurvated (Pl. 49. fig. 17 *b*). They are covered externally by a delicate sheath or sarcolemma (Pl. 49. fig. 18 *b*). The cylinders themselves consist of a clear, homogeneous, cortical substance (Pl. 49. fig. 18 *a*), and an internal cavity (*c*), the latter being filled with a finely granular substance, in which scattered nuclei are imbedded (Pl. 49. fig. 17 *c*). At the two ends of the body, the muscular fibres branch dichotomously (Pl. 49. fig. 19 *c*). The fibres are usually smooth, but sometimes longitudinally or transversely striated; this appearance arising either from folds in the sarcolemma or proper sheath, or from the granules being arranged in linear series.

In the Turbellaria, the muscular system

is but slightly developed, the tissue beneath the skin consisting of globular masses resembling the general parenchyma of the body; and in this, peculiar cellular bodies are often imbedded, resembling the urticating organs of the polypes. These enclose six, eight, or more rod-shaped bodies, which are sometimes parallel with each other, sometimes somewhat spirally curved. The cell-membrane of these bodies subsequently disappears, and they frequently project beyond the skin. Leydig figures similar rod-shaped bodies as occurring in the nuclei of the fat-cells situated beneath the skin.

In many of the Annulata, the muscular fibres are grouped into distinct bundles, serving to move the bristles, parts of the mouth, &c.

Beneath the skin at the ends of, or all over the body, a number of peculiar glands exist; these consist at the closed end of a nucleated cell (Pl. 49. fig. 19 *b d*), and a long, somewhat coiled duct opening at the surface of the body.

The *nervous system* consists of a longitudinal, single or double series of ventral ganglia, connected by longitudinal cords; the uppermost ganglion lies above the œsophagus, and the two cords which connect it with the second ganglion encircle this organ.

The uppermost ganglion is enveloped in a neurilemma consisting of longitudinal and transverse fibres, and not unfrequently peculiar pigment-cells. The cords and filaments are composed of extremely delicate primitive fibres, between which, in the ganglia, ganglion-globules are situated. The filaments distributed to the body arise principally from the ganglia.

Many of the Annulata are furnished with eyes; these are usually denoted by the brown, black, or red spots seen upon various parts of the body. It is a disputed point whether all these represent true eyes or not; but Quatrefages has described a lens, transparent cornea and vitreous humour in some of them, and he has no doubt that the red points found at the sides of each ring in several species of *Nais* are true eyes.

In some Annulata, no distinct head is present; in others this is distinguishable by its form, and is furnished with eyes and one or more filaments, which are regarded as antennæ. In those in which the head is not distinct, the mouth is situated at the anterior end of the body; in the others the mouth is on the ventral surface, and is furnished with a muscular proboscis. The mouth is usually surrounded by turgid lips, and sometimes possesses a distinct dental armature (see Hirudo). The oral aperture is frequently surrounded by a number of erectile tentacles or cirri.

The intestinal canal is usually straight, and furnished with lateral appendages, or constricted at intervals; sometimes a separate œsophagus, stomach and intestine are distinguishable. The inner, and sometimes the outer surface of the alimentary tube is covered with ciliated epithelium. A yellow or brown glandular layer surrounding the alimentary canal represents the liver.

The general arrangement of the *circulatory system* is, that two main vascular trunks, one dorsal, the other ventral, traverse the body longitudinally; and the red or green blood moves in the dorsal vessel from behind forwards, whilst in the abdominal vessel it moves from before backwards; these trunks being connected by transverse vessels or meshes of them. The anterior portion of the dorsal vessel is usually broader, and appears to form the rudiments of a heart.

The *respiration* of the Annulata is effected either by the skin; by external gills in the form of tentacular filaments or tufts, sometimes ciliated; by ciliated depressions, or by vesicles at the sides of the body. The internal convolute ciliated canals, or water-vessels, which were formerly considered respiratory organs, are now regarded as secretory tubes. In many instances a transparent colourless liquid occupies the interstices between the skin and the organs of the body; this contains colourless (rarely coloured) corpuscles much resembling the colourless corpuscles of the Vertebrata, and is considered by some to represent the true blood.

The Annulata are propagated by transverse division, by gemmation, and by means of sexual organs. The embryos are at first minute, rounded, and partially covered with vibratile cilia.

Order 1. Chætopoda (Setigera). Body ringed, elongate, with feet or setigerous rudiments of them; external branchiæ usually present.

Order 2. Suctoria (Apoda). Body elongate, ringed, without bristles or foot-like tubercles; locomotion by sucking-disks; no external branchiæ.

Order 3. Turbellaria. Body bilateral, soft, covered with vibratile cilia, not seg-

mented; eyes distinct; sexless or hermaphrodite.

Bibl. Siebold, *Lehrb. d. vergl. Anat.* i.; Jones, *An. Kingd.*; V. d. Hoeven, *Handb. d. Zool.* i.; Milne-Edwards, *Todd's Cyc. of Anat. &c.*; Johnston, *Brit. Anell.*; Gosse, *Mar. Zool.* i.; Vogt, *Zool. Briefe*; Claparède, *An. Chétopod.* (*Qu. M. Jn.* 1869, p. 306); id. *Ann. N. H.* 1867, xx. p. 337; Ehlers, *D. Borstenwürmer*, 1869; Agassiz, *Ann. N. H.* 1867, xix. p. 242; Quatrefages, *Suites à Buffon*; Gegenbauer, *Vergl. An.* 1878; R. Lankester, *An. N. H.* 1871; *Art. Anellida, Encycl. Brit.* 1875, ii.; Marion, *M. M. Jn.* 1875, xiv. 17 (coloured corpuscles in blood); Pascoe, *Zool.* 1880, p. 58; Halley, *Turbell.* 1880; Wilson, *An. N. H.* 1880, vi. 407 (devel.).

AN'ODUS, Br. & Sch. = Seligeria.

ANŒCTAN'GIUM, Br. & Sch. = Zygodon.

ANOMALI'NA, D'Orb.—With some exceptions (as *An. elegans*, D'Orb., which is a small *Discorbina*) the *Anomalinæ* are somewhat biconvex *Truncatulinæ*, neat, discoidal, and subnautiloid, with nearly as much convexity of the chambers on the lower as on the upper side of the shell. Abundant, both recent and fossil.

Bibl. D'Orb., *For. Foss. Vienn.* p. 169; Carpenter, *For.* p. 208.

ANOMALO'CERA, Temp.—A genus of Entomostraca, of the order Copepoda and family Diaptomidæ.

Char. Head distinguishable from the body, with a bifid beak and a hooked spine at the base on each side; thorax with six, abdomen with four segments; foot-jaws three pairs; last pair of legs differing from the others; eyes single, pedunculated in the male; right superior antenna with a swollen hinge-joint (in the male); inferior antennæ not branched, three-jointed, basal joint with a slender twig. 1 species:—

A. Patersonii (Pl. 16. fig. 6, the male). Marine.

Bibl. Templeton, *Tr. Entom. Soc.* vol. ii. 1837; Baird, *Brit. Entomostr.* p. 229.

ANOM'ODON, Hook. and Taylor. See Neckera and Hypnum.

AN'OPHRYS, Cohn.—A genus of Holotrichous Infusoria.

Char. Free swimming, elongate-ovate, pointed and curved in front, rounded behind; a fascicle of longer and stouter cilia issuing from the ventral oral cleft.

A. sarcophaga (Pl. 53. fig. 6). In salt water, with decaying animal matter.

Bibl. Kent, *Infus.* p. 511.

ANOPLOPH'ORA, Stein (*Opalina*, pt.).—A genus of Holotrichous Infusoria.

Char. Body elongate or ovate, nucleus band-like, axial; contractile vesicles evident.

The (15) species are intestinal parasites of *Nais*, *Lumbricus*, and other Invertebrata.

Bibl. Kent, *Infus.* p. 563; Stein, *Inf.*

ANOPLU'RA.—An order of Insects; sometimes termed Parasitica or Epizoa.

Char. Legs six; wings none; parasitic, and not undergoing metamorphosis; eyes two, simple, or none.

These insects are parasitic upon mammals and birds, and are commonly known as lice. The order is thus subdivided:—

Subord. Haustellata (Rhynchota). Mouth with a tubular, very short fleshy haustellum.

Fam. Pediculidæ. Antennæ five-jointed.

Gen. *Phthirius*. Anterior legs for walking, posterior for climbing.

Pediculus. Legs all for climbing; abdomen of seven segments.

Pedicinus. As *Pediculus*, but abdomen of nine segments.

Hæmatopinus. Legs all for climbing; abdomen of eight or nine segments.

Hæmatomyzus. Claws single.

Subord. Mandibulata (Mallophaga). Mouth with two horny mandibles.

Fam. Philopteridæ. Antennæ filiform, maxillary palpi none.

Philopterus. Antennæ five-jointed; tarsi two-jointed, claws two.

Trichodectes. Antennæ three-jointed; tarsi two-jointed, with one claw.

Fam. Liotheidæ. Antennæ clavate; maxillary palpi conspicuous.

Liotheum. Tarsi two-jointed, with two claws.

Gyropus. Tarsi two-jointed, with one claw.

It appears that although the Anoplura do not undergo metamorphosis as in the more perfect insects, consisting of larva, pupa and imago, widely differing from each other in general appearance, habits, and functions, yet a series of semitransformations takes place in the shedding of the skin a definite number of times, by which the individual acquires a greater symmetry of form, and most probably a greater perfection of parts or organs.

Bibl. Nitzsch, *Germar and Zincken's Mag. d. Entom.* iii.; Burmeister, *Gen.*

Insect.; Leach, *Zool. Misc.* iii.; Gurlt, *Thierhcilk.* viii.; Denny, *Mon. Anopl. Brit.*; id. (*Chinese*), *Qu. Mic. Jn.* 1864, p. 18; Walckenaer, *Hist. d. Insect.* xiii.; Landois, *Sieb. & Köll. Zeits.* 1865 (*Qu. M. Jn.* 1866, p. 34); Murray, *Ec. Entomol.* 1879, p. 375; Mégnin, *Parasites*, 1880.

ANOURELLA, Bory and Duj.=ANURÆA, Ehr.

ANTENNÆ, of Insects.—The two moveable jointed organs, situated on the head, near the eyes (Pl. 33. figs. 1 *a*, 3 *a*, 24 *a*, and figs. 7 to 21 inclusive).

The form, number of joints, &c. of the antennæ are used as characters for distinguishing the genera and species of Insects.

Three parts are generally recognizable in the antennæ: 1, the *scapus* or basal joint (figs. 10, 18, and 19 *a*) is often very long, and is connected with the *torulus*, or part upon which it moves, by a ball and socket articulation; 2, the *pedicella* or second joint (the same figs., *b*), which is mostly minute and nearly spherical, allowing of the freest motion, and supporting the remaining portion of the antennæ, which forms, 3, the *clavola* (figs. 10 and 18 *c*). The principal terms applied to the antennæ according to the form and arrangement of the joints of the clavola are these:—

They are called *setaceous* when the successive joints gradually diminish in size from the base to the apex, as in the families Achetidæ, Blattidæ, and Gryllidæ (fig. 7); *ensiform* when the successively diminishing joints are angular at the sides, forming a sword-like organ, as in some of the Locustidæ (fig. 8); *filiform* when all the joints of the clavola are of uniform thickness, as in the Carabidæ (fig. 9); *moniliform* when the joints are spherical or rounded, as in the Tenebrionidæ and Blapsidæ (fig. 10); *serrated* when the joints appear like inverted triangles, with the inner margin more produced than the outer, as in some of the Elateridæ (fig. 11); *imbricated* when the acute base of each joint is inserted into the middle of the broad apex of the joint behind it, as in the Prionidæ (fig. 12); *pectinated* when each joint is developed on one side into a process or spine, as in the Lampyridæ (fig. 13); *bipectinated* when a process or spine exists on each side of the joints, as in the Bombycidæ (fig. 14); *flabellate* when each of the processes is flattened, and nearly as long as the whole of the succeeding joints taken together, as in some of the Elateridæ (fig. 15); *clavate* when the clavola ends in a gradually formed knob (fig. 16), or *capitate* when the knob is suddenly formed (fig. 17), as in the Pentamerous Coleoptera; *plumose* when one or more minutely pectinated branches arises from the joints, as in some of the Muscidæ (fig. 20), or when tufts of capillary filaments arise from the joints, as in the Culicidæ (fig. 21); *lamellate*, as in the lamellicorn Coleoptera, when the knob is composed of a number of lamellæ or plates (fig. 18 *d*), and *perfoliate* when the joints of the knob are separated slightly from each other by a minute foot-stalk. There are many curious variations in the structure of the antennæ; thus, in some of the Muscidæ, the filamentous portion represents the true clavola, while the larger lobe is simply an appendage (fig. 20); in *Globaria Leachii* the pedicella is not a small rounded joint, but is elongated like the scapus (fig. 19 *b*), whilst the clavola (*c*) ends in a large capitulum attached laterally to the base of the fifth joint, and directed backwards.

The use of the antennæ is that of hearing or feeling the vibrations of the atmosphere, and of smell. B. Hicks has pointed out the existence in numerous insects of minute cavities or pits in the surface of the antennæ, furnished with a nerve-branch at the base, to which these functions are attributable. Hicks recommends the use of an aqueous solution of chlorate of potash, acidified with muriatic acid, for bleaching the chitine, and rendering these organs distinguishable.

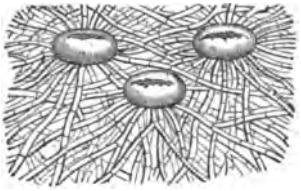
An additional function in many insects is that of common feeling or touch.

G. Hauser describes also a terminal sensory organ in the antennæ, composed of bacillar cells, connected with a largish nerve.

BIBL. Kirby and Spence, *Entomol.*; Burmeister's *Man. &c.*, transl. by Shuckard; Newport, Art. *Insects*, Todd's *Cycl. An. &c.* ii.; Westwood's *Introd. &c.*; Hicks, *Linn. Tr.* 1859, xxii. pp. 147 & 323; Claparède, *Ann. d. Sc. Nat. Zool.* 1858, x. p. 236; Hauser, *Zeit. wiss. Zool.* 1880, xxxiv. p. 367 (*Jn. Mic. Soc.* 1881, i. p. 33).

ANTENNARIA, Link.—A supposed genus of Antennariei (Phycomycetous Fungi), referred by Fries to Perisporiaceæ, and probably often consisting of forms of a Mucedinous state of CAPNODIUM. They are byssoid products growing upon dead or living structures, or sometimes in cellars. *A.* (*Racodium*) *cellaris* is the fungus of wine-cellars, and is placed by Fries in the genus *Zasmidium*.

Fig. 22 *a*.



Antennaria lævigata. Highly magnified.

Bibl. Corda, *Icones*, i. pl. 6. fig. 289; Berkeley, *Crypt. Bot.* p. 275; Cooke, *Handbook*, p. 628.

ANTENNARIEI.—A supposed family of Phycomycetous Fungi, consisting of diffuse plants, forming flocculent or byssoid patches upon leaves or bark, which appear to be merely states of other genera; the epiphytic *Antennariæ* are referred to *Capnodium*, which, like *Zasmidium* (*Antenn. cellaris*), is a Perisporiacea. Two other genera, *Pleuropyris* and *Pisomyxa*, were described by Corda, but little is known respecting them.

Bibl. Fries, *Summa Veg. Scan.* p. 406; Berkeley, *Crypt. Bot.* p. 296.

ANTENNULA'RIA, Lamk.—A genus of Hydroid Zoophytes, family Plumulariidæ.

Distinguished by the whorled, hair-like branchlets, and uniserial cells. Two British species:—

A. antennina. Main stalks simple, clustered, branchlets short. On sandy soils and stones lying in sand; deep water.

A. ramosa. Main stalks branched. On old shells and stones from deep water.

Bibl. Johnston, *Brit. Zooph.* 85; Gosse, *Mar. Zool.* i. 24; Hincks, *Brit. Zooph.* p. 279.

ANTHER.—The essential part of the male or fertilizing organ of Flowering Plans, supported on a longer or shorter stalk or *filament*, and constituting with it the *stamen*. The microscopic examination of anthers turns in two distinct, both very interesting directions, namely, study of the development and characters of the pollen produced in the anthers, and examination of the cellular structure of the walls of the perfect anther. For the former, see Pollen.

The cells of the anthers of almost all plants exhibit deposits of a more or less fibrous character, varying much in the patterns according to which the fibres are placed, and the extent to which they are developed; and these are elegant microscopic objects.

The anther is clothed with a very delicate epidermis, sometimes provided with stomata; this epidermis usually remains unaltered, but in some cases (*Lupinus*) the walls acquire fibrous thickening. Beneath this epidermis ordinarily lie one or more layers of cells which form the spiral-fibrous tissue. This may extend all round the anther, or be wanting at certain points, especially over the connective, before and behind; sometimes all the cellular tissue of the connective itself assumes the same character (with the exception of its vascular bundle).

Purkinje has furnished a most extensive notice of the conditions of these fibrous cells in the different families of Flowering Plants. The following plants are selected as affording considerable diversity of forms:—

a. Spiral fibres. *Narcissus poeticus, Populus alba, Lonicera tartarica, Hyoscyamus orientalis, Datura Stramonium, Cheiranthus Cheiri* (Pl. 40. fig. 1).

b. Annular fibres. *Iris florentina, Hyacinthus orientalis, Bunias orientalis, Cheiranthus Cheiri, Convallaria.*

c. Reticulated fibres. *Fritillaria imperialis* (on the internal face), *Tulipa Gesneriana* and *Viola odorata* (ditto), *Saxifraga umbrosa* (Pl. 40. fig. 2).

d. Fibres arched (found on three sides of the walls, the fourth being free). *Nuphar lutea, Bryonia dioica, Cynoglossum, Pulmonaria, Primula sinensis, Passiflora cærulea, Ligustrum vulgare, Cucurbita, Pyrus, Lupinus* (Pl. 40. fig. 3).

e. Fibres short and straight, pieces upon the walls standing vertically to the epidermis. *Arum, Calla æthiopica, Calceolaria, Delphinium, Anemone.*

f. Like *d*, but converging towards the centre of the upper wall of the cell, sometimes forming a star. *Corydalis lutea, Impatiens, Fumaria, Cactus* (Pl. 40. fig. 4), *Polygonum, Tropæolum majus, Veronica perfoliata, Polygala Chamæbuxus, Rubia tinctorum, Armeria.*

g. Fibres vertical, very short, numerous and close, like teeth on the walls. Grasses, *Casuarina, Myosotis, Phlomis fruticosa, Robinia, Adonis vernalis, Glaucium luteum, Chelidonium majus, Magnolia, Liriodendron, Dahlia, Leontodon, Solidago, Bellis perennis* (Pl. 40. fig. 5), *Geranium, Pelargonium, Pinus, Cupressus, Juniperus.*

b. The walls simply thickened like wood-cells. *Zamia.*

Other intermediate modifications exist; and it is necessary to observe that the character of the markings often differs in different parts of the wall of the anther. The side of the cell-wall next the cavity is that generally most marked; the outer wall lying next under the epidermis is often smooth and unmarked.

A similar structure is found on the walls of the sporanges of many of the Hepaticæ, such as *Marchantia* (Pl. 40. fig. 35), *Jungermannia*, &c. (see HEPATICÆ). Also on the walls of the sporanges of *Equisetum* (see EQUISETACEÆ). For further particulars respecting the relations of these cells to other spiral-fibrous tissues, see SPIRAL STRUCTURES.

BIBL. Purkinje, *De cell. anther. fibrosis*, Wratislaviæ, 1830; Sachs, *Bot.* 1874, 525.

ANTHERIDIA.—The general name applied to all the various structures in which, certainly or probably, the fertilizing function of reproduction resides in Flowerless Plants, and which consequently correspond physiologically to the anthers of the Flowering Plants. They differ to some extent in the character of the final products, which are extremely minute bodies, some exhibiting spontaneous motion when placed in water.

The antheridia of the higher Flowerless Plants, those with leaf and stem, produce active filaments, coiled more or less in a spiral form, and the motion is here connected with the presence of cilia upon the spiral filaments. With regard to those of the Thallophytes, the antheridia are not everywhere so well understood. Their existence is clearly ascertained in the Fucaceæ, and the active bodies are ciliated. The function of the so-called antheridia of the Florideæ is not yet proved, and it is denied by Thuret that the antherozoids (or spermatozoids) have a power of motion; recent researches among the Confervaceæ have shown the existence of antheridial cells, producing active spermatozoids, to be very general in that order. In the Fungi and Lichens the antheridia seem to be represented by a different kind of structure, which produces minute stick-shaped bodies, apparently not endowed with spontaneous motion.

The moving bodies from the antheridia are called *spermatozoids*, *antherozoids*, or *spermatic filaments* in the higher Cryptogamia. The active bodies of the Fungi and Lichens have been provisionally named *spermatia*.

The antheridia of the Marsileaceæ are represented by the smaller form of spore produced in the sporanges (see MARSILEACEÆ). This is also the case in regard to the Lycopodiaceæ so far as *Selaginella* and *Isoëtes* are concerned (see LYCOPODIACEÆ). In the Ferns and Equisetaceæ the antheridia are produced along with the archegonia on the prothallium or cellular frond resulting from the germination of the spore (see FERNS and EQUISETACEÆ). In the Mosses and leafy Liverworts, the antheridia are produced in terminal or axillary buds, associated with or separate from the archegonia (fig. 23). In the frondose Liverworts, they are imbedded in the frond, or more or less raised from it on special receptacles (see MOSSES and HEPATICÆ).

Fig. 23.

Bartramia fontana. Male inflorescence with antheridia and paraphyses. Magnified 40 diameters.

The antheridia are represented in the Characeæ by the so-called globule, in which are produced filamentous spermatozoids resembling those of Mosses (see CHARA).

Antheridia occur in Saprolegniæ (Pringsh. *Jahrb.* Bd. vi. p. 249 &c.; *Tab. Fungi*, fig. 26), and have been observed in *Tuber* and *Peziza*. (See Pringsh. *Jahrb.* Bd. ii. p. 378 &c.; De Bary, *Ann. d. Sc. Nat.* Juin 1866, p. 343; Tulasne, *ibid.* Déc. 1866, p. 211.)

The supposed antheridial organs of the Lichens are called *spermogonia*, and will be found described under LICHENS; and the analogous structures found in certain Fungi called by the same name, are described under CONIOMYCETOUS FUNGI, also under the heads of certain genera of that family. The antheridia of the Algæ are described under FUCUS, FLORIDRÆ, ŒDOGONIUM, VAUCHERIA, SPHÆROPLEA, VOLVOX.

ANTHEROZOIDS.—The term applied by the French authors to SPERMATOZOIDS.

ANTH'INA, Fries.—A genus of Isariacei (Hyphomycetous Fungi), composed of minute fibrous plants, often of bright colours, growing upon dead leaves &c. in autumn. One British species is recorded:—

A. flammea, Fr. Attenuated downwards, smooth, crimson-saffron, dilated upwards, feathery, yellow. *Clavaria miniata*, Purton.

A beautifully coloured Fungus, varying as to the degree of ramification, scarcely 1-2″ thick at the base; thickened upwards, as also are the branches; fibrous and feathery at the summit; solitary; from 1-2″ to 1″ high; turning blackish when dried. The spores separate very readily when the specimens are placed in water for examination.

It may, however, be doubted whether even *Anthina flammea*, which occurs occasionally in considerable quantity amongst dead leaves in shady woods, is an autonomous fungus, though it may be difficult to point out of what species it may be a state, unless it be related to *Thelephora multizonata*, Berk.

Bibl. Purton, iii. t. 18; Nees and Henry, *Syst. d. Pilze*, 1837, t. 6; Fries, *Summa Veget.* p. 465.

ANTHO'CEROS, Mich.—A genus of Anthocerotæ (Hepaticæ).

The forms found in Britain are regarded by Hooker as varieties of one species. By the continental botanists they are divided into two: *A. punctatus*, with the frond dotted and divided at the margin; and *A. lævis*, with the frond smooth (fig. 24).

Fig. 24.

Anthoceros lævis. Magnified 2 diameters.

These plants are found in very moist situations, at the sides of ditches &c., fruiting in spring. The ovate-oblong fronds are from ½ to ¼ of an inch long, lying flat, and often forming round patches, overlapping one another, radiating from a centre, and more or less divided at the margin. The texture is between membranaceous and fleshy, inclining to the latter; the colour deep green, lighter at the margins. The antheridia and archegonia are usually abundant on the same individual. The antheridia are spherical, with short stalks, of a yellowish-orange colour, included in cup-shaped, deeply toothed receptacles on the upper face of the fronds. The young archegonia differ from those of any other Hepaticæ in their structure, since, instead of free, flask-like cases, they are tubular cavities running down from the upper face of the frond, with an embryonal cell at the bottom, which increases by degrees into a conical body, and finally emerges on the surface, surrounded by a perichæte continuous with the epidermis of the frond. The conical body by degrees grows up into the narrow pod-like sporange, which attains a length of about 2 inches, and is supported on a short pedicel, 2 to 3 lines high, almost concealed in the perichæte. The sporange splits down the middle into two valves, which become slightly twisted, and leave in the centre a thread-like column, to which adhere for a time many of the spores and elaters. The spores,—the development of which has been a subject of much study, and is very instructive,—from the long sporange containing specimens of successively older formation from one extremity to the other,—are of the ordinary character of these tribes, having a reticulated outer coat, marked by ridges indicating the mutual pressure of the four spores formed in each parent-cell. The elaters are much simpler than usual, consisting merely of membranous tubes, not very long, but sometimes irregularly curved or branched, without any spiral fibre in their interior. Gemmæ also occur on the frond of *Anthoceros*.

Bibl. Dev. of the Fruit generally: Hofmeister, *Höhern. Kryptogamen*, Leipsic, 1851; Schacht, *Entw. d. Frucht und Spore v. Anthoceros lævis*, *Bot. Zeit.* 1850. Spores: Mohl, *Linnæa*, 1839; *Vermischte Schrift.*, Tübingen, 1846; Nägeli, *Veget. Cells* (*Ray Society*), 1846, p. 229; Carrington, *Brit. Hep.*, 1881; Sachs, *Bot.* 351.

ANTHOCEROTEÆ.—A tribe of Liverworts or Hepaticæ (which see), containing one British genus, Anthoceros.

ANTHO'PHORA, Latr.—A genus of Insects, of the order Hymenoptera, and family Apidæ.

Char. Wings with three complete submarginal cells of equal size; labial palpi with the third joint affixed obliquely; maxillary palpi 6-jointed; intermediate legs of male with long brushes of hair.

There are two species, *A. retusa* and *A. Haworthana*.

A. retusa (mason bee) is commonly seen flying about sunny and sandy banks from March to the beginning of June. Its head and trophi are represented in Pl. 33. fig. 24.

The *antennæ* (*a*) are inserted in the centre of the face, not approximating, short, geniculated, and 13-jointed in the male; basal joint (scapus) very pubescent, second (pedicella) globose, third as long as the first, fourth shorter than any of the following, which are oblong; they are similar in the female, but a little longer, and 12-jointed. *Labrum* (*e*) deflexed, convex, with two black

spots at the base, anterior margin a little convex and ciliated. *Mandibles* (*f*) slightly curved, clothed with long hairs, notched near the apex; larger in the females, and but slightly notched below the apex. *Maxillæ* (*g*) with the basal portion short and broad, hairy, the edge above pectinated, terminal lobe long and lanceolate, with a small pencil of hairs at the apex. *Palpi* (*h*) rather long and setaceous, 6-jointed, basal joint short, second long, the remainder decreasing in length. *Mentum* rather short and linear. *Tongue* (*) very long and slender, ringed and tubular, the interior margins very pilose, terminated by a lanceolate appendage. *Paraglossæ* (*x*) lanceolate. *Palpi* (*k*) extending as far as the tongue, slender, tapering, 4-jointed, basal joint very long, second not half the length, ciliated towards the apex, third inserted below the apex, and very small, as well as the fourth. Head subtrigonate; eyes (*c*) long and narrow; ocelli (*b*) three. Thorax much broader than the head in the female. Legs rather robust; tibiæ, posterior dilated and very pilose externally, and the intermediate ones also in the females; tarsi, intermediate pair long in the males, the basal joint of the 4 posterior dilated in both sexes, and furnished with a strong brush at the apex in the hinder pair of the female. Claws bifid in the males, with a tooth on the underside in the female. Pulvilli distinct. Male thickly and minutely punctured, and clothed with fulvous or yellowish hairs, more or less black at the apex of the abdomen; female black, very pilose. See INSECTS.

BIBL. Curtis, *Brit. Entomol.* viii. p. 357; Westwood, *Introd.* &c. ii. p. 277.

ANTHOPHY'SA, Duj.—A genus of Infusoria, of the family Monadina, Duj.; Flagellata, Kent.

Char. Bodies ovoid or pyriform, with a single anterior flagelliform filament (two, one shorter than the other, Kent), and aggregated at the ends of the branches of a support or polypidom, which is secreted by them. The groups, when free, resemble *Uvella*, and revolve in the liquid containing them.

The branched support is of an irregular arborescent form, at first soft and glutinous, afterwards becoming brownish, horny, and nodular in appearance. According to Cohn, the brownish filaments so frequently found in decomposing pond- &c. water, are the stalks of *Anthophysa*, and form Kützing's genus *Stereonema*.

A. Müllerí (*vegetans*) (Pl. 30. fig. 13). Body thicker in front; length of stalks 1-250 to 1-120″, length of single animal 1-2000″, Fig. 13 *b* represents a detached animal with the larger flagelliform filament. This is the *Epistylis vegetans* of Ehrenberg. The detached groups of bodies form a species of *Uvella*, Ehr. (*Uvella uva* ?). Fresh water, common.

A. socialis. Bodies about 8 in a group. On *Confervæ*.

BIBL. Dujardin, *Infus.*; Ehr. *Inf.*; Cohn, *Nova Acta*, 1854, p. 109; *Ann. N. Hist.* 1866, xviii. p. 429; Kent, *Inf.* p. 266.

ANTHOSO'MA, Leach.—A genus of Crustacea, of the order Siphonostoma, and family Ergasilina.

Found upon the gill-covers and gills of sharks.

BIBL. Baird, *Brit. Entom.*; Desmarest, *Cons. génér. sur l. Crustac.*

ANTIGRAM'MA, Presl.—A genus of Scolopendrieæ (Polypodiaceous Ferns). Exotic.

ANTIMONIATE of soda.—The production of this salt by the addition of antimoniate of potash to a neutral or alkaline solution of a salt of soda, is used as a test of the presence of soda. The crystals are represented in Pl. 10. fig. 21.

BIBL. See CHEMISTRY.

ANTIMONY. See ARSENIC.

ANTITRICHIA, Br. and Sch.=NECKERA.

ANT'LIA.—The spiral tongue or proboscis of the Lepidoptera.

This well-known beautiful organ (Pl. 33. fig. 28), when extended, forms a long suctorial tube, and when coiled up represents a flat spiral, like the spring of a watch. It consists mainly of two modified maxillæ (see INSECTS). According to Newport, each maxilla is composed of an immense number of short transverse muscular rings; these are convex externally and concave internally, and the two connected organs form a tube. Within each there are one or more large tracheæ (fig. 28 *c**‡) connected with the tracheæ in the head. The inner or concave surface which forms the tube (fig. 28 *c*†) is lined with a very smooth membrane, and extends along the anterior margin throughout the whole length of the organ. At its commencement at the apex (fig. 28 *f**), it occupies nearly the whole breadth of the organ, and is smaller than at its termination near the mouth, where the concavity or groove does not occupy more than about 1-3rd of the breadth. In some

species, the extremity of each maxilla is furnished along its anterior and lateral margin with a great number of minute papillæ. These, in *Vanessa Atalanta* (the red admiral butterfly) for instance, form little barrel-shaped bodies (fig. 28 *b*, *a*, *f*), furnished at the free end with three or more marginal teeth, and a larger pointed body in their centre. There are seventy-four of these in each maxilla, or half the proboscis. Newport regards them as probably organs of taste. There are also some curious appendages arranged along the inner anterior margin of each maxilla, in the form of minute hooks, which, when the proboscis is extended, serve to unite the two halves together, by the points of the hooks in one half being inserted into little depressions between the teeth of the opposite side; sometimes these are furnished with a tooth below the apex (fig. 28 *e*).

This description of the structure of this interesting organ does not appear to be correct. We believe that the older view, regarding each half of the Antlia as containing a distinct canal, to be true, and that the transverse rings, in fact the entire frame-work of the organ, consists of chitine. But the subject requires further investigation. The only muscular structure we have detected in the organ, consists of bundles of muscular fibres taking an oblique longitudinal direction.

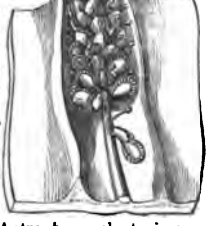
Bibl. Newport, *Todd's Cycl. of An. and Phys.* ii. p. 901; Hicks, *Linn. Tr.* 1860, xviv. p. 148. See also Insects.

ANTRO'PHYUM, Kaulf.—A genus of Polypodiaceous Ferns, fam. Grammitideæ.

Char. Sori carried along the veins, imperfectly reticulated, superficial or immersed in a groove.

Fronds simple, of firm fleshy texture, with uniform hexagonal areolæ. 16 species; exotic.

Fig. 25.



Antrophyum plantagineum. Part of a sorus. Magnified.

Bibl. Hooker, *Sp. Fil.* p. 392.

ANURÆ'A, Ehr.—A genus of Rotatoria, of the family Brachionæa.

Char. A single (red) eye-spot at the back of the head, no foot or pediform tail.

In seven species the back of the carapace is furnished with facets, in four with longitudinal striæ, in three it is smooth; in thirteen it is furnished with teeth or spines in front, in seven also behind. One species, *A. biremis*, has two moveable spines on each side.

Dujardin gives the following characters. Carapace in the form of a depressed utricle or sac, toothed in front and with a wide orifice to allow of the protrusion of the rotatory organs, which are usually well developed in the form of two rounded lobes, accompanied by setæ or non-vibratile cilia in several bundles; no tail; jaws digitate; a red eye-spot above the jaws; ova voluminous, often adherent to the parent.

The species are both aquatic and marine, and many of them are common in pure fresh water; length from 1-240 to 1-10".

Ehrenberg describes 14 species; to which Gosse adds 4.

A. curvicornis, E. (Pl. 43. fig. 5, viewed from above; fig. 6, side view).

Bibl. Ehr. *Infus.*; Duj. *Infus.*; Gosse, *Ann. N. H.* 1851, viii. p. 202.

ANYS'TIS, Heyd. (*Erythræus*, Dugès; *Trombidium*, Herm.).—A genus of Arachnida, of the order Acarina, and family Trombidina.

Char. Palpi large, free, bi-unguiculate; mandibles unguiculate; body entire; legs at their insertion contiguous, cursorial, *i. e.* unguiculate, long, the last joint slender and very long; posterior legs the longest.

A. parietinum. Colour vermilion; legs pale. Found between stones and in moss; and on book-shelves. *Tromb. parietinum*, Herm. *Mém. Apt.* p. 37, pl. 1. f. 12.

A. ruricola. Body very minute, depressed, nearly oval, slightly emarginate at the sides, and broader behind than before; a few hairs scattered over the surface; eyes two, black, placed at the anterior obtuse angles of the body; colour bright carmine, sometimes blackish in the middle, paler along the back and in front; legs and palpi colourless, except a bright red spot on each at a little distance from the body. On stones and on dry paths. (Pl. 50. fig. 4, and Pl. 2. fig. 3.)

A. flava. Yellow.

A. ignipes. Mottled with greyish brown and yellowish red.

A. cursoria. Rose colour.

A. cornigera. Red with two blackish lines down the back.

Actineda, Koch, is not generically different from *Anystis* (Murray).

Bibl. Hermann, *Mém. Aptérol.*; Dugès,

Ann. d. Sc. Nat. 2 sér. i. and ii.; Koch, *Deutsch. Crust.* &c.; Heyden, *Isis*, p. 160; Gervais, *Walckenaer's Hist. d. Ins.* iii.; Murray, *Econ. Entom.* p. 140.

APATITE, see ROCKS.

APHANIZOM'ENON, Morren (*Limnochlide*, Kützing).—A genus of Nostochaceæ (Confervoid Algæ) forming a delicate bluish-green mucous stratum on the surface of lakes or standing water. The filaments are very slender, flaccid and obscurely jointed. The spermatic cells are much elongated, either scattered or, more frequently, solitary near the centre of the filament. Allman inclines to think they are formed by confluence of adjacent cells; he found vesicular cells (heterocysts) also, which Ralfs did not describe. This genus seems to form a connecting link between the Oscillatoriaceæ and Nostochaceæ, as indicated by Hassall. Ralfs enumerates three British species, viz.—

A. Flos-aquæ, Linn. (Pl. 8. fig. 1).—Filaments about 1-3000″ in diameter, cohering laterally in flat lamellæ which separate at their extremities into fasciculi; spermatic cells cylindrical, with an inconspicuous covering.—Ralfs, *An. N. Hist.* 1850, v. pl. 9. fig. 6; *Limnochlide Flos-aquæ*, Kütz. *Tab. Phyc.* cent. i. pl. 91. fig. 2 *a*.

A. cyaneum, Ralfs. Filaments free, aggregated into a thin mucous stratum; sporangia linear, 8 to 12 times longer than broad, with a conspicuous hyaline covering.—Ralfs, *l. c.* pl. 9. fig. 7. *Limnochlide Flos-aquæ*, var. *hercynica*, Kütz. *Tab. Phyc.* c. i. pl. 91. fig. 11?

A. incurvum, Morren. "Filaments articulated, cohering together in flat laminæ, laciniated at the apex; articulations 2 to 8 times longer than broad." Ralfs states that the Irish specimens identified by Morren do not agree with this character, being held together by the mucous matrix rather than cohering, as in *Flos-aquæ*, and they are neither fasciculated nor laciniated at the ends.—Ralfs, *l. c.* pl. 9. fig. 8. *Aph. incurvum*, Thompson, *An. N. H.* 1850, v. 82; Hassall, *Algæ*, t. 76. fig. 6. *Limnochlide Flos-aquæ*, var. *Harveyana*, Kütz. *Tab. Phyc.* c. i. pl. 91. fig. 2.

BIBL. Ralfs, *Ann. N. Hist.* 1850, v. 339; Allman, *Qu. Mic. Jn.* iii. p. 21, and the other works cited above.

APHANOCAP'SA, Näg.—A genus of Confervoid Algæ; consisting of spherical green cells, imbedded in an amorphous gelatinous mass.

A. virescens (Pl. 3. fig. 2). On wet rocks and stones. Other species.

BIBL. Rabenhorst, *Fl. Alg.* ii. p. 48.

APHANOCHÆ'TE, Braun.—A genus of Chætophoreæ (Confervoid Algæ) allied to *Coleochæte*; the bristles arising from the backs of the cells are not sheathed, but jointed in the upper part. Not yet detected in Britain.

BIBL. Braun, *Verjung.* p. 196 (Ray Soc. transl. 1853, p. 184); Rabenhorst, *Alg.* iii. p. 390 (fig.).

APHANOTHE'CE, Näg.—A genus of Confervoid Algæ.

Char. Cells minute, rounded or oblong, æruginous, enclosed in a gelatinous envelope.

A. microscopica (Pl. 3. fig. 3). In marshy places, everywhere. Many other species.

BIBL. Rabenhorst, *Alg.* ii. p. 63.

APH'IDÆ.—A family of Insects belonging to the order Hemiptera (Homoptera, Westwood). This family comprises the insects known as plant-lice.

Rostrum more or less perpendicular or inflexed, varying in length, being in some species longer than the body, and consisting of four joints (Pl. 36. fig. 1). Labrum long and pointed at the tip. Antennæ of moderate or of great length, setaceous or filiform, and usually composed of 3–7 joints, the last joint being sometimes obsolete and the third longest (Pl. 36. fig. 2). Ocelli three to six in number, forming a large triangle; eyes compound, prominent, and semiglobose. Thorax oval, with the prothorax forming a transverse collar; abdomen short and convex, ovate or elongate-ovate, soft, and generally furnished with a more or less elongated tubercle or cornicle on each side near the extremity. Wings, when present, four; the anterior much larger than the posterior, placed obliquely or nearly perpendicularly on the sides of the body in repose; the anterior with a strong subcostal nerve, terminating near the apex in a broad stigma, and giving off two or three oblique nerves running to the posterior margin of the wing; of these the one nearest the apex is usually forked once or twice. These variations in the arrangement of the postcostal nerve form the distinguishing characters of the Tribes (Buckton). A papilla with three bent hooks on the costal margin of the hind wings, works in a fold of the posterior margin of the anterior wing, somewhat as in the Hymenoptera. Legs usually very long and slender, with the thighs some-

times thickened; tarsi two-jointed. The body is sometimes clothed with a mealy or cottony secretion, secreted by roundish warts which stand in rows upon the back; in some species this covering is so long that the animal is entirely concealed by it, and looks merely like a moving flock of wool. It is sometimes employed by the females as a covering for their eggs.

The Aphidæ, like the rest of the order to which they belong, are active in all their stages; the pupæ being distinguishable from the perfect insects only by their possessing the rudiments of wings upon the back of the thoracic segments. In the wingless species this distinction of course does not exist.

These insects reside, usually in large societies, upon almost every species of plant; but the different species of plant-lice, like the true lice of animals (Anoplura), are generally restricted to one or two particular plants; or when they are common to a greater number of vegetable species, the latter are usually very nearly allied. Each species is also restricted to some particular part of the plant; but no part is exempted from the attacks of particular species, which are found upon the young shoots, the buds, the leaves, the stem, even of trees, and the roots. Of these parts they suck out the juices, by placing the rostrum in a perpendicular position, and forcing the included bristles into the tissues of the plant; the wound thus formed is frequently enlarged by movements of the body of the animal. In some instances the irritation caused by these wounds, inflicted by a colony of Aphides, gives rise to a distorted state of leaves and twigs, and even to gall-like excrescences, in the interior of which the insects may be found in great numbers.

The abdominal tubercles or tubes above mentioned, which, however, are reduced to simple openings in some species, are generally regarded as excretory organs, through which a saccharine fluid is exuded. This fluid is produced by many Aphides, especially those which live upon trees and shrubs, in great abundance; it constitutes the well-known honey-dew, which drops in large quantities from some of our common trees (particularly the Lime), and forms small shining spots upon their leaves. The latter were supposed by Liebig to be products of a disease of the plants upon which they occur. The sweet fluid is much liked by ants and other Hymenopterous insects, which seek the Aphides for the purpose of sucking it from them, sometimes inducing them to excrete it by stroking them with their antennæ, but sometimes biting and tearing them to get at it. Kaltenbach considers the abdominal tubes to be merely produced stigmata, and states that the saccharine fluid is emitted through the anus; this is also the opinion of De Geer, Kyber, and others.

The propagation of the Aphides presents some most remarkable peculiarities, and is well worthy of a careful study. The ordinary colonies of these insects, which may be met with everywhere during the summer, consist of winged and wingless individuals, the latter being for the most part larvæ and pupæ. The winged individuals are all viviparous and capable of producing young larvæ without any intercourse with a male insect. During the whole course of the summer, none but these so-called viviparous females are to be met with, and generation follows generation without the appearance of a single male. It is only in the autumn that males and true females are produced as the last result of the viviparous reproduction; the latter are usually apterous, even in the ordinarily winged species; and, after copulating, the females lay eggs, which serve to continue the race in the following summer. The viviparous individuals of some species are, however, said to live through the winter; and the viviparous reproduction may be continued uninterruptedly for an indefinite period by the maintenance of the necessary conditions of temperature &c.; at least Kyber observed it for four consecutive years in a colony kept in a room at a uniform temperature. The males are rarer, mostly alate, and with a smaller abdomen.

The true nature of this wonderful mode of propagation has been the subject of much dispute, especially of late years. It will be unnecessary for us to enter upon the consideration of the various opinions that have been put forward; it is sufficient to mention that it is now generally admitted to be an example of the alternation of generations or parthenogenesis, which occurs so frequently amongst the lower animals,—the viviparous forms being regarded as the products of a sort of internal gemmation. According to Huxley, the organs in which the young of the viviparous forms are produced (*pseudovaria*) are strictly homologous with the true ovaries, and the germs of both forms are identical, (the existence of the germinal spot

in the pseudova is, however, denied); but in the oviparous females, the germ is surrounded by a vitellus and vitelline membrane in the usual way to form a true egg; whilst in the viviparous individuals the germinal vesicle itself enlarges and undergoes a considerable change before acquiring an investing membrane, within which the embryo is gradually developed. Balbiani, however, maintains that the viviparous Aphides are really hermaphrodite.

From the nature of their production, it will be easily understood that the fecundity of the Aphides must be very great. The most prolific species only live for about three weeks, and in that time produce 30–40, or, according to Réaumur, 90–100 young. In these species there may be from 15–17 generations in the course of the summer; and Schrank, starting from Bonnet's observations, calculated the total theoretical progeny of a single Aphis in the course of one summer at 23,740,000. Their numbers are, however, constantly kept in check by the attacks of numerous enemies, amongst which we may mention the common Lady-birds, both in their larva and perfect states, the larvæ of the Dipterous genus *Syrphus*, and of the Hemerobiidæ, which prey upon them; whilst many of the smaller Ichneumonidæ and Chalcididæ attack them for the purpose of depositing eggs in their bodies.

Notwithstanding these checks upon their production, the plant-lice increase sufficiently to render them exceedingly injurious to cultivated plants. The most noxious species are the turnip-fly (*Aphis Brassicæ*, Pl. 36. fig. 3), the bean-fly (*A. Papaveris*), which also occurs upon the poppy and various other plants, and the hop-fly (*A. Humuli*). The latter, when it abounds to an unusual extent, causes the almost total destruction of the crop of hops. One of the most abundant species is the rose-fly (*A. Rosæ*), which is often exceedingly injurious to roses in gardens, by attacking the young succulent shoots. *Lachnus Quercus*, a large species with the rostrum three times the length of the body, is found in the fissures of the bark of old oaks; the other species of *Lachnus* live for the most part upon the shoots and leaves of coniferous trees; the commonest is *L. pinicola*. *Eriosoma lanigera* (Pl. 53. fig. 3) is a common species upon the stems of apple-trees, living in societies in crevices of the bark, on which it forms small, white, woolly patches. *Tetraneura Ulmi* (Pl. 36. fig. 4) lives in small gall-like excrescences on the leaves of the elm; and the *Pemphigus bursarius* (Pl. 36. fig. 5), a woolly species, resides in similar galls on the leaves and foot-stalks of the poplar. Of the subterranean species, which suck the roots of plants, the most abundant is *Trama radicis* (Pl. 36. fig. 6), which occurs upon various composite plants, including the common dandelion and the garden-lettuce. *Forda formicaria* (Pl. 36. fig. 7) is the species commonly found in ants' nests; it lives in small societies on the roots of grasses, and is tended with great care by the ants. *Phylloxera vastatrix* (Pl. 53. fig. 7) is the vine-pest.

The colouring-matter of the Aphides partakes of the nature of chlorophyll (Sorby).

Bibl. Westwood, *Introd. &c.*; Walckenaer, *Hist. d. Ins.*; Kaltenbach, *Monog. d. Pflanzenläuse*, 1843; Koch, *Aphiden*, 1857 (figs.); Burnett, *Silliman's Jn.* 1854, xvii. pp. 62, 261; Walker, *Ann. N. Hist.* 2nd ser. i. ii. iii. iv. &c. (1848–49); Claparède, *Ann. N. Hist.* 1867, xix. p. 360; Balbiani, *ibid.* 1866, xviii. pp. 62, 106; id. & Signoret, *ibid.* 1867, xx. pp. 20, 149; Boisduval, *Entom. Hort.* p. 240; Huxley, *Linn. Tr.* xxii. pp. 193, 221; Sorby, *Tr. Mic. Soc.* xi. p. 352; Buckton, *Aphides* (*Monogr.*), *Ray Soc.* 1876.

APHRODITA, L.—A genus of Annulata. One species of this genus (*A. aculeata*) is well known as the sea-mouse, and is commonly found on the sea-coast, and always admired on account of the splendid iridescent colours reflected from its spines and bristly hairs. Body from 3 to 5 inches long, 1½ broad, and oval; back of an earthy colour. Head small, entirely concealed, with two round clear spots, or eyes, on the vertex. The hairs and bristles run down each side of the body; the back is roughish, with a thick felt of hair and membrane forming a kind of skin. When this is cut through, fifteen nearly circular plates or scales (elytra) are found on each side, which partly cover each other. If two of the plates lying next each other be separated, we then see upon the intermediate ring small tubercles divided by a pit, furnished behind with pectinate appendages, the gills or branchiæ.

Antennæ minute; palpi large, subulate, jointed at the base. Mouth with a large retractile edentulous proboscis; the orifice encircled with a short, even, thick-set fringe of compound penicillate filaments divided

into two sets by a fissure on each side. Thirty-nine pairs of feet, biramous; the upper branch carries the long, flexible, brilliantly coloured bristles forming the silky fringe on each side of the body.

This animal is a very interesting object to the microscopist, as its tissues are very transparent and easily examined.

The brilliant colours of the bristles and hairs arise from iridescence, produced by a number of longitudinal striæ or interspaces between the component fibres of which the bristles and hairs consist; they also exhibit transverse splits or cracks; they are not materially changed by the action of boiling solution of potash, except that the external coat of the hairs becomes transversely wrinkled, giving these the appearance of being surrounded by a number of fibres (Pl. 49. fig. 20).

Bibl. Johnston, *Ann. N. Hist.* 1839, p. 430; Van d. Hoeven, *Zool.* p. 232.

APHROSI'NA, Carter.—A minute, parasitic, poriferous Foraminifer, with numerous irregular, vesicular chambers. Allied to *Carpenteria*.

Bibl. H. J. Carter, *J. Micr. S.* ii. 500.

APHTHA.—A disease affecting the mucous membrane of the mouth, tongue, &c. It exhibits itself in the form of rounded patches of larger or smaller size, of a whitish or yellowish colour. One form of it, vulgarly called the "thrush," and in French *muguet*, which occurs very frequently in children, and in adults towards the fatal termination of chronic diseases, is of special interest, inasmuch as the patches consist of numerous epithelial scales mixed with the filaments and isolated cells of a fungus (*Oidium albicans*). A portion examined under the microscope exhibits:—1, numerous oval cells (*a*, Pl. 38. fig. 1), rarely containing an internal globule or nucleus; 2, long filaments (*b*) exhibiting a further advanced stage of development; the filaments are but rarely jointed; 3, epithelial scales, sometimes perfect (*d*), but usually wrinkled and otherwise altered in form, and frequently more or less opaque (*e*), so as to be hardly recognizable except when treated with potash; intermingled with these bodies are sometimes vibriones or bacteria (*Bact. termo, f*) and a molecular form of matter (*g*), probably an early stage of *Bact. termo*; for it is always found with and prior to it in decomposing liquids, in addition to the molecular granules found in all animal liquids.

This fungus appears to arise in the same manner as other analogous fungi, as those in kept organic liquids, in urine, &c.; the spores are probably always floating in the air and dropping from it upon all the exposed parts of the body; and wherever they find a proper nidus, there they grow. In diseases accompanying or preceding aphtha, the regeneration of the oral epithelium is probably to a great extent checked, the secretion of the saliva also, which would wash away these organisms; why they occur so frequently in infants, is probably owing to the saccharine nature of the diet, which is especially favourable to their development.

It is to be observed of the numerous parasitic Fungi which have been described as preying on animal tissues, that a great portion are mere conditions of common species of *Aspergillus*, *Penicillium*, *Mucor*, &c., which assume different forms according to the nature of the matrix. This has not been sufficiently kept in view by authors unacquainted with the genera of Fungi; and in consequence, a great number of spurious genera have been proposed, and considerable confusion has ensued; while the fashion of late with Hallier and his followers has been to confound things which are essentially distinct. See Oidium.

Bibl. C. Robin, *Hist. Nat. d. Vég. Parasites*, 1853, p. 488, where many other works are mentioned.

APIOCYSTIS, Nägeli.—A genus of Palmellaceæ (Confervoid Algæ). Aquatic plants parasitical upon Confervæ, consisting of pear-shaped or clavate vesicles from 1-50″ to 1-20″ high, and about half as thick, attached by the narrow extremity, and containing numerous green primordial cells about 1-2500 to 1-3500″ in diameter. Young sacs contain regularly 2, 4, 8, 16, 32, &c.; and in large ones the number amounts to 300 to 1600. At first they lie irregularly in the cavity, afterwards they lie upon the wall in one or more layers; sometimes they are attached to the wall in groups of eight. At a certain stage, the primordial cells become again free in the cavity, move actively, and finally escape by the rupture of the sac, swarm as biciliated zoospores for a time, then settle down and germinate.

A. Brauniana (Pl. 5. fig. 5); in ditches, &c. Brit.

Bibl. Nägeli, *Einz. Algen*, p. 67, t. 2. A. figs. 1 and 2; Henfrey, *Tr. Mic. Soc.* 1856, iv. p. 49, pl. 4; *Rab. Alg.* iii. p. 43.

A'PIS, L.—A genus of Hymenopterous Insects.

A. mellif'ica, the honey-bee, presents some interesting points of structure.

The proboscis (Pl. 33. fig. 25) agrees essentially with that of *Anthophora*. The "tongue" (labium*) is a very beautiful and favourite microscopic object; its minute structure requires a higher power than that used in making our sketch, to render distinct the elegant transverse ridges or folds and the terminal hairy lobe.

The legs are peculiarly formed for the special purpose of collecting and carrying the pollen of flowers. The tibiæ of the hind legs are dilated, smooth on the outside in the neuter or working bees, and hollowed into a shining plate (Pl. 34. fig. 4*b*), whilst the basal joint of the tarsi is hooked at its outer superior angle and dilated into an oblong or somewhat triangular plate (Pl. 34. fig. 4*a*), which is furnished with transverse rows of hairs, forming pollen-brushes.

Bibl. Westwood, *Intr.* &c.; Curtis, *Brit. Ent.* 769.

APLANATISM.—Freedom from spherical aberration (in lenses).

APLIDIUM, Sav.—A genus of Mollusca, of the order Tunicata, and family Botryllidæ.

The common mass is from 1 to 3 inches high; and the animal bodies about $\frac{1}{8}$–$\frac{1}{2}$ inch long. Four British species:—

A. ficus, dark olive, orifices six-rayed; *A. fallax*, honey-yellow, with white and brown specks, orifices circular; *A. nutans*, straw-yellow, tinted with brown, orifices invisible; and *A. verrucosum*, olive-green, orifices entire.

Bibl. Forbes and Hanley, *Brit. Mollusca*, i. 10.

APOTHECIUM.—The name applied to the female or spore-fruits of the Lichens. Several special names have been applied to the apothecia, namely, *pelta*, *scutella*, *patella*, *scyphus*, *orbiculus*, *lirella*, and *verruca*, indicating the forms occurring in particular genera. They are shield-shaped, flat, cup-shaped, globular, papilliform bodies, or linear ridges, upon the upper surface of the thallus, either immersed, superficial, or elevated on peduncles. They contain the thecæ or spore-cases. For the structure, see Lichens.

Fig. 26.

Dirina Ceratonia.

Fig. 27. Fig. 28.

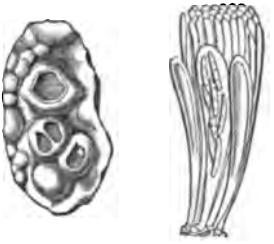


Fig. 27. Apothecia, magnified. Fig. 28. Thecæ and paraphyses, from a vertical section of an apothecium, magnified 200 diameters.

APPENDICULARIA, Cham.—A genus of Mollusca, of the order Tunicata, and family Salpidæ.

1 British species: *A. flagellina*.

Bibl. Gosse, *Mar. Zool.* i. p. 37; Chamisso, *Nova Acta Acad. Cur.* x.; Huxley, *Phil. Trans.* 1851, p. 595.

APTOG'ONUM, Ralfs.—A genus of Desmidiaceæ.

Char. Filament elongated, triangular or flattened; joints bicrenate at the free margins; an oval foramen between the joints.

Kützing and others placed this organism in the genus *Desmidium*, where it might very well have remained.

A. Desmidium. Joints in front view quadrangular, broader than long.

a. Filaments triangular, regularly twisted, crenatures rounded; length of joints 1-1500″, breadth 1-1000″ (Pl. 14. fig. 55, front view; fig. 52, side view).

β. Filaments flattened; crenatures shallower and slightly angular.

A. Baileyi. Filaments not crenate; joints about equal in length and breadth. American.

The latter cannot be retained in this genus, unless the characters be altered, on account of the absence of the crenatures

Bibl. Ralfs, *Br. Desmid.* pp. 63, 208.

A'PUS, Scop.—A genus of Entomostraca, of the order Phyllopoda, and family Aspidephora.

Char. Head, body, and greater part of the abdomen covered by a shield-like carapace, which is deeply notched behind; eyes two, sessile and approximate; a single pair of minute, short, styliform and two-jointed antennæ; legs, sixty pairs, the first pair furnished with three long jointed branches, extending beyond the carapace, the rest branchial; body composed of numerous rings; two long jointed caudal appendages.

A. cancriformis. Freshwater, in stagnant pools; brownish yellow; length 2½ inches.

A. productus. Not British; an elongated oval lamina between the two caudal appendages.

Bibl. Baird, *Brit. Entom.* p. 18; R. Lankester, *Qu. Micr. Jn.* 1881, xxi. p. 343.

ARACHNI'DA.—A class of animals containing the spiders, scorpions, &c.

Char. Head united with the thorax, forming a cephalothorax; antennæ none; eyes simple (ocelli); legs eight, jointed.

The integument of the Arachnida is usually soft and leathery, rarely horny or brittle, and consists principally of chitine. Two layers may usually be distinguished, an outermost or cuticle, which is the firmest and strongest, and not unfrequently exhibits a cellular appearance in the extremities and the cephalothorax. The cuticle of the abdomen of the Araneæ, Acarina, &c. presents very beautiful wavy or undulating lines, sometimes surrounding the roots of the hairs &c. concentrically, and arising, in some cases at least, from the existence of folds (Pl. 6. figs. 4 & 5). The cuticle of the Arachnida is frequently covered with warty and bulbous excrescences, bristles and simple or feathery hairs, and sometimes with scales.

The innermost cutaneous layer consists of a very delicate and almost colourless membrane, of a finely granular or fibrous appearance, close beneath which is situated a layer of pigment granules and cells, which are visible through the general integument, and to which the beautiful colours of many of the Arachnida are owing.

The organs surrounding the mouth vary in structure in the different families. In the Spiders, two mandibles are situated at the front of the head. These consist of two joints—a basal, very thick one (Pl. 6. fig. 6 *a* & 7 *a*), and a terminal, curved and sharply pointed one (fig. 6 *b* & 7 *b*). The latter is traversed by a canal terminating at its apex, through which the secretion of a poison-gland passes into any body transfixed by the claw. These mandibles are perhaps, strictly, modified antennæ. Next come two maxillary palpi (fig. 7 *c*), which do not differ in structure from the legs, except in their tarsi being composed of a single joint, generally terminated in the females by a small hook, but in the males of more complicated structure: the basal joints of these palpi are enlarged and project forward, forming the maxillæ (fig. 7 *d*); these are stated to contain certain glands, opening on the inner side of the upper face. In the scorpions, the mandibles and maxillary palpi terminate in pincers or forceps. Lastly a labium, situated between the maxillæ (fig. 7 *e*), and consisting of a single piece.

The mouth in the other families is described under the respective heads.

The eyes are simple (ocelli, stemmata), but they are absent in the parasitic Acarina; they consist of a simple arched cornea, a spherical lens and a concavo-convex vitreous body, with a cup-shaped retina, and a layer of pigment corresponding to the choroid.

The cephalothorax is usually separated from the abdomen by a well-marked constriction; but sometimes the head, thorax, and abdomen are fused together.

The legs of the Arachnida, which are attached to the cephalothorax, do not coincide exactly with those of insects. They usually consist of seven segments tapering towards the end, so that the tarsi are less distinct from the other parts than in insects. If we suppose that the last two joints belong to the tarsus, the tibia then consists of two joints, of which, in some (the scorpion and *Phrynus*) the first, in others the second, is the longest. The preceding long joint is the femur, next to which comes an annular or inverted conical joint, corresponding to the trochanter of the six-footed insects. The first, broad, usually inversely conical joint, which is adherent to the cephalothorax, corresponds to the coxa of insects. The last joint of the tarsus usually supports three curved hooks or claws (Pl. 6. fig. 8), which are frequently toothed on the concave margin, and in some a membranous vesicular or hairy cushion (pulvillus) on its under side. The most characteristic feature of the Arachnida consists in the division of the tibia into two unequal pieces.

The first pair of legs is supposed to represent the labial palpi of insects.

The *alimentary canal* is mostly short and straight. In the Araneæ the œsophagus enlarges into a prismatic muscular expansion just before its termination in the sto-

mach; the stomach splits just behind the above apparatus into two branches, which curve forwards and form a ring, from which five pairs of diverticula pass to the roots of the legs and palpi.

Salivary glands are present, consisting in the Araneæ of a transparent glandular mass situated in a cavity above the palate; also a hepatic apparatus, in the form of a compact mass, consisting of a number of ramified and closely-crowded cæca, containing the hepatic cells and opening at about the middle of the alimentary canal in four short ducts. This hepatic apparatus was formerly mistaken for the fat-body. In the Tardigrada, Acarina, and some others the liver is represented by the granule-cells, usually brownish yellow, of the walls of the diverticula of the stomach.

The poison-glands of the Araneæ consist of two long, sometimes slightly curved blind sacs, the walls of which are surrounded by a simple spiral layer of muscular fibres.

Circulatory System.—In the lower Arachnida, as the Tardigrada, Acarina, &c., there is neither dorsal vessel nor blood-vessels. Hence in these there is no regular circulation of blood, but the nutritive fluid or the blood is distributed free in the interstices of the body, and is irregularly moved backwards and forwards, propelled in the cavity of the body, and into the extremities, by muscular movements and the contractions of the intestinal canal.

In the Araneæ there is a dorsal vessel consisting of a spindle-shaped tube lying principally in the abdomen, constricted at intervals and furnished with lateral apertures and valves. This heart sends off lateral and terminal arterial branches, which gradually become lost. There are no veins; but the further course of the blood takes the form of lacunal currents, which re-enter the heart at the valvular orifices.

In the scorpions, there are veins as well as arteries.

Respiratory System.—In the Tardigrada and some parasitic Arachnida, *Demodex*, *Sarcoptes*, *Acarus*, &c., no tracheæ or other respiratory organs have yet been discovered; hence the respiration must be cutaneous. The higher Arachnida breathe either by tracheæ (many Acarina), or by lungs, or by both.

The tracheæ of the Acarina are remarkably delicate, so that the spiral fibre is with great difficulty distinguishable. They arise usually in an unramified bundle from two stigmata, which are sometimes situated anteriorly, between the front legs, as in the Hydrachnea, and much concealed, at others at the sides of the body above the third pair of feet, as in the Gamaseæ, or behind the last pair, as in the Ixodeæ. They are usually more tufted than branched as in insects.

In the Hydrachnea, which live in the water, and do not rise to the surface to respire, the tracheæ must possess the power of absorbing the air from the water. In the Araneæ, the lungs consist of rounded sacs situated at the anterior part of the under surface of the abdomen, and open externally by a transverse slit. At the outer convex surface of each lung-sac there are a number of thin but firm triangular or rhomboidal plates, like the leaves of a book, closed together (Pl. 6. fig. 9). When examined by reflected light, they present a silvery lustre; whilst by transmitted light they appear dark violet or almost black. Each of these plates consists of a fold of the skin, between which the air of the sac is widely distributed: they contain on blood-vessels; hence probably the blood brought by the arteries is poured out around the lungs, and so bathes the lung-plates. The position of the lung-sacs is indicated externally by a triangular and horny cutaneous plate, at the posterior margin of which the respiratory fissure exists. Behind these fissures there are two other openings, the orifices of a tracheary system which does not differ materially from that of such as have tracheæ only.

Nervous System.—Varies in degree of complexity. In its simplest form it exists as a single œsophageal ganglion, sending off radiating branches; and in its most compound forms it presents a large cephalothoracic bilobed ganglion, and one or two ventral ganglial chains or cords.

The primitive nervous fibres and ganglion-cells are very small and delicate.

Spinning-organs.—These organs, by means of which the Araneida form their webs, are of great interest. The external organs consist of three or rarely two pairs of cones or conical papillæ, or spinnerets, placed at the end of the abdomen, below the anus: they are somewhat flattened at the summit; and usually the middle pair consist of two joints, and the anterior and posterior pairs of three joints. The sides of the cones are covered with hairs; and on the summits are a number of delicate horny spinning-tubes, at first sight closely resembling hairs; these form continuations of the spinning-vessels. Sometimes, however, the lower portions of the sides of the cones are furnished with spinning-

tubes, the remainder being covered with hairs. Each spinning-tube consists of two parts:—a thicker basal portion; and a thin terminal portion, from the orifice of which the substance of the fibre exudes (Pl. 6. fig. 10, 10 *a*, separate tubes). The number of these spinning-tubes varies according to the species, the sex, and the age of the spiders. In some there are more than 1000, in others 400, 300, 100, &c., and in others still fewer. The glands which secrete the tenacious transparent secretion are very variable in number, form, and arrangement, and occupy the interstices of the other abdominal viscera, consist of sacs and tubes, lined with nucleated cells, and either simple or variously ramified, terminating in ducts which open at the roots of the spinning-tubes.

The filaments of which the webs of many spiders are composed are not all alike. The radiating filaments are but little elastic, and are composed simply of one or more threads; whilst the more numerous (tangential) filaments connecting these are covered at tolerably regular intervals with minute spherical masses of glutinous matter (Pl. 6. fig. 11), the filaments themselves being highly elastic. These masses give the fibres an elegant beaded appearance under low powers of the microscope. The viscid masses cause the more ready adhesion of the filaments to insects which may accidentally become entangled in them, and render the spider more sure of holding his prey.

Propagation.—The Arachnida generally are propagated by sexes. The sexual apparatus consists of two ovarian or seminal sacs, sometimes fused together in the middle line; they are situated in the abdomen, and terminate in two excretory ducts, which usually open at a common orifice placed at the base of the abdomen, or below the cephalothorax. A penis is not generally present; the seminal fluid is applied to the vulva of the female by the maxillary palpi of the male. Parthenogenesis has been observed in Acarina.

Spiders are oviparous; the eggs are enveloped in a cocoon, and are often elegantly sculptured.

There is no metamorphosis, but repeated ecdysis.

The Arachnida may be thus subdivided:—

Order 1. Araneida. Cephalothorax constricted from the unjointed abdomen; palpi unarmed.

Order 2. Pedipalpi (Phrynida). Cephalothorax distinct from the jointed abdomen; palpi large, leg-like, chelate at the end. (Pulmonary sacs present.)

Order 3. Solifugæ (Solpugida). Cephalothorax distinct from the jointed abdomen; palpi filiform, extended, as long as the legs, unarmed.

Order 4. Pseudoscorpiones (Obisida); Book-scorpions. Cephalothorax distinct from the ringed abdomen; palpi large, chelate. (Tracheæ only present.)

Order 5. Phalangita (Opilionina); Harvest-spiders. Cephalothorax distinct from the annulate or transversely plicate abdomen; palpi simple, filiform; mandibles chelate; legs very long, terminated by a single claw.

Order 6. Acarina (Mites). Head, thorax, and abdomen fused together; legs distinctly jointed; palpi simple.

Fam. 1. Acarea. Head terminated in front by an emarginate labrum, or single bifid process; palpi adnate or adherent to the labium, difficultly distinguished; mandibles chelate; no distinct ocelli; legs generally terminated by a vesicle or adhesive acetabulum and claws.

Fam. 2. Oribatea (Beetle-mites). Body covered by a hard horny envelope; mandibles chelate; palpi fusiform, 5-jointed; legs furnished with claws, but no vesicle or acetabulum.

Most of the species live in mosses at the roots of trees; in some the body is surrounded by a projecting lamella on each side.

Fam. 3. Ixodea (Ticks). Palpi canaliculate, sheathing the rostrum; mandibles three-jointed, basal joint internal, second joint external and long, third short and denticulate; labium covered with reflexed teeth. (Parasitic.)

Fam. 4. Gamasea (Insect-mites). Palpi free, filiform; mandibles chelate; feet with two claws and a caruncle, or a lobed membranous appendage; ocelli none or indistinct. (Generally parasitic.)

Fam. 5. Hydrachnea (Water-mites). Palpi with the last joint unguiculate or spinous; two or four distinct ocelli; coxæ broad, legs generally ciliated, natatory, the posterior longest. (Aquatic.)

Fam. 6. Bdellea (Snouted mites). Palpi antenniform; mandibles terminating in claws or pincers; rostrum resembling an elongated head; body generally divided between the second and third pairs of legs by a transverse furrow or stricture.

The species are minute, more or less soft, variously coloured, and living in

damp places beneath moss, upon sand of caves, &c.

Fam. 7. Trombidina (Harvest-mites). Palpi with the last joint obtuse, the second joint very large; the last but one (penultimate) resembling an incurvated claw; feet cursorial, terminated by two claws.

Fam. 8. Hypoderidæ (Subcutaneous mites). Oval-oblong, almost transparent sacs; the anterior and posterior pairs of legs widely apart; tarsi terminated by two fine hairs.

The species are found in the subcutaneous tissue of birds.

Fam. 9. Phytoptidæ (Gall-mites). Legs four, the hinder pairs replaced by tubercles or hairs.

In the galls and buds of plants.

Order 7. TARDIGRADA (Colopoda); Water-bears. Legs rudimentary, very short, conical, indistinctly three-jointed, and with three or four claws; abdomen not distinct from the thorax. (Aquatic.)

Order 8. PYCNOGONIDA (Polygonopoda); Crab-spiders. Cephalothorax forming a 4-jointed body; abdomen rudimentary (small and conical); legs as long as or longer than the body.

Sluggish marine animals, living under stones, upon marine plants, or parasitic upon fish and crustacea.

BIBL. Treviranus, *Bau der Arachn.*; id. *Vermischte Schrift. &c.* Bd. 1, 1816; Dufour, *An. d. Sc. physiq. d. Brux.*, iv.–vi.; Walckenaer, *Hist. nat. d. Ins. Apt.*, i.–iii.; Siebold & Stannius, *Lehrb. d. vergl. An.* i.; Blackwall, *Brit. Spiders* (*Ray Soc.*) 1861–4, and *Linn. Tr.* xvi.; Blanchard, *Ann. N. H.* 1850, vi. 67; and 1852, x. 150; Newport, *Phil. Tr.* 1843; Koch, *Uebersicht &c.*, and *Arachnid.* (534 pls.); Claparède, *L'évol. &c.* 1863; id. *Circulation, &c., Ann. N. H.* 1865, xv. p. 16; Cambridge, *Encyl. Brit.* 1875, ii; Jones, *An. Kingd.* 1870; Gegenbaur, *Vergl. Anat.* 1878; Walker, *Brit. Spiders* (*Ray Soc.*): Murray, *Econ. Ent.* p. 33.

ARACHNID'IUM, Hincks.—A genus of Ctenostomatous Polyzoa (Bryozoa), fam. Arachnidiidæ.

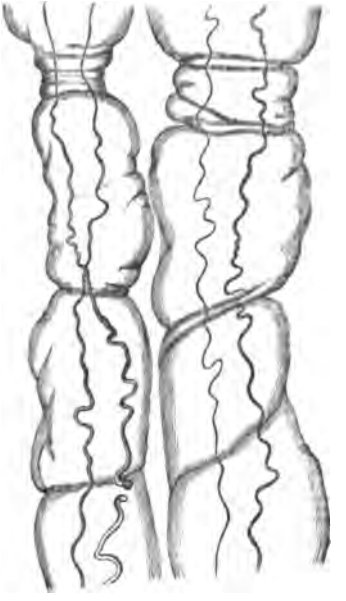
Three British species.

BIBL. Hincks, *Polyzoa*, 1880, p. 508.

ARACHNOID MEMBRANE (*Tunica arachnoidea*).—Is a delicate transparent membrane, lying between the cranial dura mater and the brain, and extending between the spinal cord and its dura mater so as to envelope these nervous centres. It does not dip between the convolutions of the brain, but enters and lines its ventricles. Its outer surface is covered by a delicate epithelial layer; its inner surface is smooth, but not covered with epithelium. It is reflected upon the surface of the dura mater as an epithelial layer only. It consists principally of reticulated bundles of connective tissue, with fibres of elastic tissue coiling around or pursuing a rectilinear course through them. In some parts the fibrillæ of the former run parallel without forming bundles, and contain, as do the bundles, round, elongated, or spindle-shaped nuclei. In others, connective tissue of a rather homogeneous appearance here and there forms a coat to the bundles, or is situated between them.

Fig. 29 represents two bundles of the connective tissue of the human arachnoid, after the addition of acetic acid, showing the fibres of elastic tissue.

Fig. 29.



Connective and elastic tissue of arachnoid, after treatment with acetic acid. Magnified 350 diameters.

BIBL. Kölliker, *Mik. An.* ii.; Henle, *Allgem. Anat.*

ARACHNOIDIS'CUS, Bailey (Hemiptychus, Ehr.).—A genus of Diatomaceæ.

Char. Frustules adherent, disk-shaped;

valves plane or slightly convex, with radiating and concentric lines (rows of dots), and a central pseudo-nodule.

The markings upon the inner valves are not the same as those upon the outer (or parent): hence the mere variations of the markings are not characteristic; nor is the number of rays constant.

A. ornatus, Ehr. Valves very finely granular; rays 29, equal. In Patagonian guano.

A. Ehrenbergii, Bail. Pseudo-nodule surrounded by an inner ring of linear radiating and an outer ring of circular or angular markings (depressions); marine; breadth 1-200 to 1-60″; occurs also in guano. (Pl. 16. figs. 12 & 13, side view.)

A. indicus (Pl. 51. fig. 3). } Fossil in
A. nicoburicus (Pl. 51. fig. 4). } Nicobar Islands.

Bibl. Ehr. *Ber. d. Berl. Ak.* 1848 & 1849; Smith, *Br. Diat.* i. p. 25; Shadbolt, *Tr. Mic. Soc.* iii.; Arnott, *Micr. Jn.* 1858, p. 159; Greville, *Micr. Tr.* 1865, p. 47.

ARACHNOS'PIS, Kent.—A genus of Infusoria, fam. Halteriidæ.

Bibl. Kent, *Infus.* p. 214.

ARACHNU'LA, Cienk.—A genus of Rhizopoda.

Char. Naked, colourless, without nucleus; one or more contractile vesicles; pseudopodia branched, very slender, anastomosing; bodies connected by thickish cords. Movement active.

A. impatiens. In brackish water. Black Sea.

Bibl. Cienkowski, *Sch. Arch.*, 1876, xii. p. 27.

ARANE'IDA.—A family of Arachnida, comprising the true spiders.

The species of genera belonging to this family (as *A. civilis* and *domestica*, house-spiders, *Epeira diadema*, garden-spiders &c.) are readily accessible for examining the structural peculiarities of spiders—the skin, the eyes, the organs of the mouth, the maxillary palpi, the spinnerets, the legs, &c. (See Pl. 6.)

Bibl. Walcken., *Aptères*, i.; Koch, *Arachn.* viii.; Treviranus, *Bau d. Arachn.*; Walker, *Brit. Spiders*; Murray, *Ec. Ent.* p. 43.

ARAUCA'RIA, Jussieu.—A genus of Coniferæ (Gymnospermous Flowering Plants), remarkable for the character of the markings on the walls of the cells of the wood, where the pits or bordered pores appear in two or more parallel rows (Pl. 48. fig. 5). *Araucaria* (*Eutassa*) *excelsa* is the Norfolk-Island Pine, which grows to an immense size, as do also *A. brasiliensis*, *A. imbricata*, &c. The reservoirs of turpentine seem to be in the bark and not in the wood. See Coniferæ, Wood, and Secondary Layers.

ARAUCARITES, Goeppert (*Dadoxylon*, Endlicher; *Pinites*, Lindl. and Hutt.).—A genus of Fossil Coniferæ, characterized by a structure resembling that of Araucaria.

Bibl. Witham, *Fossil Vegetables*, p. 72, pl. 4–11. Edinb. 1833; Lindley and Hutton, *Fossil Flora*, l. t. 2, 3.

ARCEL'LA, Ehr.—A genus of Rhizopoda, of the family Arcellina.

The Arcellæ correspond to Amœbæ contained in a carapace. In some species the carapace is membranous and uniform; in others it is calcareous and exhibits fine striæ, depressions, or granules spirally arranged.

A. vulgaris (Pl. 30. fig. 14*a*). Carapace brownish yellow, plano-convex, or hemispherical, covered with depressions. These markings or depressions are very beautiful and interesting. They agree with those upon the valves of the Diatomaceæ in regard to the requirements for their display; with unilateral oblique light, lines only are visible. Their true structure resembles that in Pl. 15. fig. 41, or Pl. 17. fig. 29, except that the rows are somewhat wavy or even spiral. Fr. wat.; breadth 1-500 to 1-200″. In the young state it is very transparent and pale, and the markings are with difficulty distinguished. The shell is cast several times before arriving at maturity. Pl. 32. fig. 24 represents the animal with its processes protruding from the carapace.

We have seen two of these animals conjugating, and so firmly united by the soft internal substance, that they were not separable by rolling them over between two plates of glass.

A. (*Echinopyxis*) *aculeata* (Pl. 30. fig. 14 *b*). Carapace brownish, discoidal, convex above, with one or more irregular spinous prolongations at the margin; fr. wat.; breadth 1-200″ without the spines.

A. dentata (Pl. 30. fig. 14 *c*). Hemispherical, anguloso-polygonal; carapace membranous, homogeneous, yellowish or greenish; fr. wat.; breadth 1-560 to 1-200″.

A. aureola (*Cyphidium auroleum*, Ehr.) (Pl. 30. f. 38). Carapace yellow, angular, with numerous tubercles, four of which are larger and more projecting; a single expansion of varied size; breadth 1-560 to 1-420″; fr. wat. Fig. 38 *a* represents the carapace viewed from above, *b* the same supported upon one angle, and the single expansion.

A. arenaria; in sand, under moss and lichens. Other species.

BIBL. Ehrenberg, *Infus.*; Claparède and Lachmann, *Infus.* p. 444; Bütschli, *Schultze's Arch.* xii. 459 (pl.).

ARCELLI'NA, Ehr.—A family of Lobose Rhizopoda.

Char. Animals contained in a univalve membranous or solid inflexible carapace, of an urceolate or shield-like form, with a single orifice from which one or more irregular and variable expansions are protruded, which form the organs of locomotion.

Bütschli describes conjugation; but the result is doubtful.

The substance of the body resembles that of an *Amœba*. Gen.:—

Shell flexible, dorsal..... *Pseudochlamys.*
Shell flexible, universal ..... *Amphizonella.*
Shell solid, inflexible.
  Not incrusted with foreign matters. *Arcella.*
  Incrusted with agglutinated foreign matters.
    With tubular prolongations ..... *Echinopyxis.*
    Without tubular prolongations... *Difflugia.*

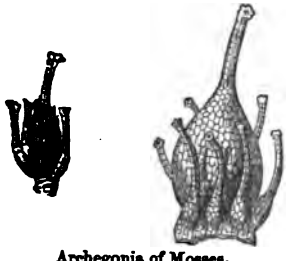
ARCHÆDIS'CUS, Brady.—A small, lenticular, asymmetrical, hyaline Foraminifer, of the Nummuline type; found in the Carboniferous Limestone.

BIBL. Brady, *Ann. N. H.* 1873, xii. 286.

ARCHEGO'NIUM. Also called *pistillidium*.—The rudimentary organ representing the ovule in the higher Flowerless Plants, such as Mosses, Ferns, &c. (excluding the Thallophytes). These organs are more minutely described under the heads of the various Classes, in speaking of their reproduction.

In the Mosses and Liverworts they are flask-like cellular bodies, found in terminal

Fig. 30. Fig. 31.



Archegonia of Mosses.
Magnified 50 diameters.

or axillary buds on the leafy stems (figs. 30 & 31). In the Ferns and Equiseta they are produced on the prothallium, after the germination of the spores. In the Lycopodiaceæ and Marsileaceæ they are produced upon the cellular plate, representing a prothallium, developed in the large spores when these begin to germinate. The *corpuscula* of the Coniferæ are analogous bodies to the last. See HEPATICACEÆ, MUSCACEÆ, FILICACEÆ, EQUISETACEÆ, LYCOPODIACEÆ, MARSILEACEÆ; also CONIFERÆ and CHARACEÆ.

ARCHIDI'UM, Bridel.—A genus of Phascaceæ (Acrocarpous Mosses), of which but one species is found in Europe (*A. phascoides* = *Phascum alternifolium*, Hook. and T.), growing upon banks and fallow ground, on clay or chalky soil. It is remarkable for the sessile globular capsule, without a trace of an operculum, the columella soon obliterated, and the spores being few in number, very large and angular in form (figs. 32 &

Fig. 32. Fig. 33.

Archidium.
Open capsules devoid of columella and with large spores. Magnified 40 diameters.

33). The calyptra is torn away in the middle during the expansion of the capsule, as in *Sphagnum*, leaving a short tumid vaginula.

BIBL. Wilson, *Bryol. Brit.* p. 24.

ARCTO'A, Br. and Sch. = DICRANUM.

ARCYRI'A, Hill.—A genus of Myxomycetes, growing on rotten wood, with frequently bright-coloured spores and filaments. The elastic filaments of the capillitium have no spiral fibres, but are a little tuberculated. The species in general are not confined to Europe or the United States, but have a very wide geographical range, occurring in tropical and subtropical districts as well as in those which are temperate. Species:—

A. punicea, Pers. Common; spores and capillitium purplish vermilion. A dark form is separated by Rostafinski as *A. ferruginea*. Grev. *Sc. Crypt. Fl.* t. 130.

A. incarnata, Pers. Not uncommon; smaller, with a shorter stipes and with flesh-coloured spores and capillitium.

A. cinerea, Bull. Spores and capillitium cinereous.

A. nutans, Bull. Spores and capillitium dirty-yellow; capillitium nodding. *Trichia*

nutans, Sowerby, t. 260; *Arcyria flava*, Grev. *Sc. Crypt. Fl.* t. 309.

A. umbrina, Schum. Spores and capillitium ochraceous, capillitium erect; peridium ovate.

A. ochroleuca, Fr. Spores and capillitium pale-ochraceous, peridium globose, evanescent; smaller than the preceding; 1-12″ high.

BIBL. Berk. *Hooker's Brit. Fl.* ii. pt. 2. p. 318; *Crypt. Bot.* p. 337; Fries, *Summa Veget.* p. 456; Rost. *Sluzowce*; Cooke, *Myx.*

ARE'CA, L.—A genus of flowering plants (Fam. Palmaceæ). The albumen of the seed of the *Areca catechu* (the Areca nut, as it is called) affords a good instance of horny consistence produced by secondary layers upon the cell-walls (Pl. 38. figs. 21 & 22). See ALBUMEN (of seeds).

AREG'MA, Fries.—A genus of Coniomycetous Fungi closely allied to *Puccinia*, comprising the species with many cells which occur on various Rosaceæ, as the common dark parasite of the Rose and Bramble. Like *Puccinia*, the species always seem connected with a Uredinous form, and are propagated by secondary spores produced on the multiseptate bodies after germinating.

BIBL. Fries, *Summa Veg.* p. 507; Berk. *Crypt. Bot.* p. 325; Tulasne, *Ann. d. Sc. Nat.* 1847, Jan. p. 12; De Bary, *Ueb. d. Brandpilze.*

ARE'OLAR TISSUE of animals. See CONNECTIVE TISSUE.

AR'GAS, Walck.—A genus of Arachnida, of the order Acarina and family Ixodea.

Char. Rostrum inferior, concealed, as also the palpi, beneath a projection of the anterior part of the body; under part of body granular, not scaly, and consisting of a single piece; first joint of the palpi longest; legs approximate at their insertion, feet terminated by two claws, but no vesicle.

These animals are frequently parasitic upon pigeons, fowls, &c.; some live in gardens.

A. reflexus (*Rhynchoprion Columbæ*, Herm.). Body marked with tortuous furrows and depressions, yellowish or violet after food. On pigeons, especially when young.

A. persicus. Blood-red colour, back covered with scattered elevated white spots. The venomous bug of Persia; said to cause death in the human subject.

There are other species.

BIBL. Gervais, *Walcken. Aptères*, iii.; Murray, *Ec. Entom.* 180 (figs of all species); Mégnin, *Paras.* 1880, 133.

AR'GULUS, Müll.—A genus of Crustacea, of the order Siphonostoma and family Argulidæ.

Char. Carapace membranous, covering the cephalothorax like a shield; antennæ four, short, concealed beneath the carapace, anterior two-jointed, terminal joint hooked; posterior four-jointed; rostrum acuminate; five pairs of legs, the place of the first (6th) pair being occupied by two suckers; second pair short, five jointed, the two basal joints spinous, the last joint with two small hooks; the last four pairs of legs two-cleft, and furnished with ciliated filiform processes.

A. foliaceus (Pl. 20. fig. 1). Parasitic on the stickleback (*Gasterosteus*) and other fishes; carapace greenish.

BIBL. V. d. Hoeven, *Zool.*; Baird, *Brit. Entom.* p. 242; Thorell, *Ann. N. H.* 1866, xviii. p. 149.

ARPAC'TICUS, Baird.—A genus of Entomostraca, of the order Copepoda and family Cyclopidæ.

Char. Head undistinguishable from thorax; foot-jaws two pairs, forming strong cheliform hands; antennæ in male furnished with a swollen hinge-like joint; antennules (inferior antennæ) simple; legs five pairs, the fifth pair rudimentary; eye single; ovary single. Two species:—

A. chelifer and *A. nobilis.* Marine, closely resembling *Cyclops.*

BIBL. Baird, *Brit. Entom.* p. 212.

ARRENU'RUS, Dugès.—A genus of Arachnida, of the order Acarina and family Hydrachnea (= Caudate Hydrachnæ).

The posterior part of the body of the male is narrowed and produced into a truncate or cylindrical appendage. The body of the female is truncated posteriorly. The prolongation is terminated by two angles and a sinuous intervening margin. At the middle of the latter is situated the penis; above which are two hooks. In both sexes the back is hard, crustaceous, as if shagreened, or spinous. In some species the thicker layer of the skin is furnished with a number of conical apertures (Pl. 6. fig. 12). The eyes are two, distinct, blackish. The intestinal cæca are distinguishable through the skin. The mouth is round and surrounded by a kind of hood (Pl. 6. fig. 13, *c*).

Arrenurus viridis, Dugès's typical species (Pl. 6. fig. 13), has the palpi short and clavate (*a*); the fourth joint longest and largest, the fifth falcate, and the mandibles ungui-

culate (*b*). According to Murray, this is the male of *Atax histrionicus*!

The species are very numerous and of almost all colours—red, green, yellow, grey, purple.

Bibl. Walcken. *Aptères*, iii.; Dugès, *Ann. d. Sc. N.* 2 sér. i.; Koch, *Uebersicht &c.*; Murray, *Ec. Ent.* p. 154.

ARROW-ROOT.—A name given to various kinds of starch, derived from the plant *Maranta arundinacea* and other species. True West-India arrow-root is from this (Pl. 46. fig. 26) and *M. allonga* and *M. nobilis* (N. O. Marantaceæ). East-India arrow-root is obtained from species of *Curcuma* (N. O. Zingiberaceæ) (Pl. 46. fig. 19), and apparently also from a *Sagus*, if we may judge from a specimen (Pl. 46. fig. 18) from Singapore. Tahitan arrow-root (Pl. 46. fig. 22) is obtained from the plant called *Tacca pinnatifida* (N. O. Taccaceæ); and the substance called Portland arrow-root (Pl. 46. fig. 11) is extracted from the *Arum maculatum* (N. O. Araceæ), a common hedge-weed in this country. In all these cases the fecula consists of starch-grains, which are produced in great quantity before the season of rest, in the succulent tubers or rhizomes of the plants; the arrow-root is extracted from the grated root-stalks by washing, to separate the cellular tissue and remove the often acrid juices. See Starch.

The arrow-root of the shops is subject to adulteration with cheaper kinds of starch, especially with sago and potato-starch.

Bibl. Pereira, *Mat. Med.*; Hassall, *Food and its Adulterations*, p. 31.

ARSENIC.—The common term for arsenious acid. Arsenious acid assumes two crystalline forms, and occurs also in an amorphous state.

The most common form is the octahedral or tetrahedral. The second (right rhombic) is less common, and is only obtained by sublimation. Attention to the form of the crystals is important, because it is used as a means of identifying arsenic in cases of poisoning. It must, however, be borne in mind that protoxide of antimony ($Sb O_3$) yields crystals by sublimation of exactly the same form as those of arsenious acid (Pl. 10. fig. 22).

Solution of arsenious acid is sometimes used as a preservative liquid for animal preparations.

Bibl. Guy, *Mic. Tr.* 1861, p. 54.

ARTE'MIA, Leach.—A genus of Entomostraca, of the order Phyllopoda and family Branchiopoda.

Char. Abdomen prolonged in the form of a tail, composed of nine segments or joints, the end joint simply divided into two lobes; superior antennæ slender and filiform in both sexes; inferior antennæ in the male large, flat, curved downwards and two-jointed, resembling horns; in the female short, pointed and slightly curved; basal joint of male inferior antennæ provided with a short conical process.

A. salina. The Lymington shrimp or brine-worm. Found in the salt-pans at Lymington. Length about 1-2″.

Each segment of the thorax shortly bilobed at the apex, and with a pair of branchial feet; each lobe of the end joint of abdomen giving off several short setæ. Agrees generally in structure with *Branchipus*.

Bibl. Baird, *Brit. Entom.*; Rackett, *Linn. Tr.* xi.

ARTERIES.—These are the tubes or vessels which convey the blood from the heart to the various parts of the body. The structure of the arteries is very complicated and difficult of investigation; and the coats or tunics of which they consist are so intimately connected as to be by no means easily separable.

In the *larger* arteries, three coats are usually distinguishable, an outer or adventitious coat, a middle, and an inner coat or *intima*, with its epithelial lining. Their composition and thickness vary in arteries of different sizes.

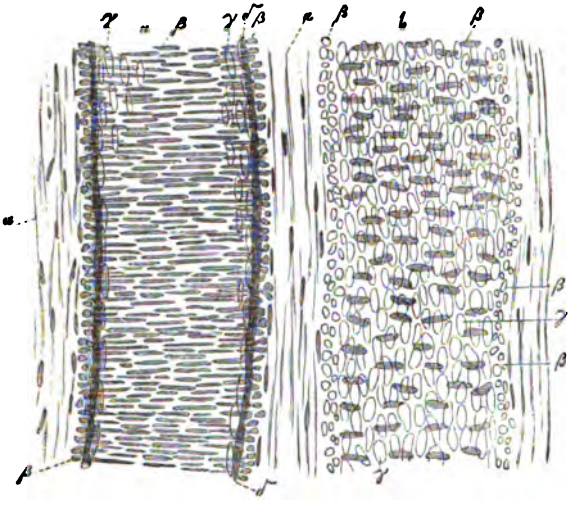
The general character of the arteries is that the middle coat is thick and strong, consisting of several layers, and its elements run transversely. In the largest arteries it is yellow, very elastic and of great strength; as the vessels become smaller, it diminishes in thickness, becoming redder and more contractile; and near the capillaries it is very thin, finally disappearing. The inner coat is always thin, yet thickest in the large vessels; whilst the outer coat is absolutely thinner in these than in those of a moderate size, in which it equals or even exceeds the middle coat.

In the *small* arteries the epithelial lining consists of very delicate pale, flattened, fusiform cells with longish oval nuclei.

An elastic layer is expanded beneath the epithelial layer, which is smooth in the living vessels, whilst in these, when empty, it exhibits numerous transverse or longitudinal folds. It forms what is called a fenestrated membrane, generally exhibiting more or less distinct reticulated fibres, and usually

small elongated openings; more rarely a very dense network of principally longitudinal elastic fibres, with narrow elongated fissures.

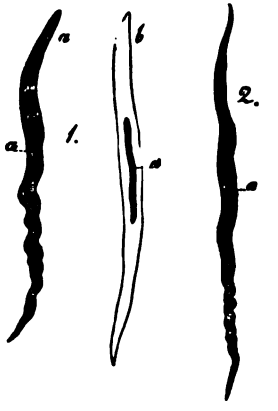
Fig. 34.



Magnified 350 diameters.

A small artery (*a*) and vein (*b*) (about 1-180″ in diameter) from the mesentery of a child, after the addition of acetic acid: *a*, external coat, with elongated nuclei; *β*, nuclei of the muscular fibres of the middle coat, partly seen from the surface, partly the sectional view; *γ*, nuclei of the epithelial cells; *δ*, fibrous layer of elastic tissue.

Fig. 35.



Magnified 350 diameters.

Muscular fibre-cells from human arteries. 1, from the popliteal; *a*, before, *b*, after the addition of acetic acid; 2, from a twig of the anterior tibial artery: *a*, nuclei.

The middle coat of the smaller arteries is purely muscular. The fibres or fibre-cells, which are transverse and connected into layers, may be isolated by dissection, or by maceration and boiling in a mixture of nitric acid with four parts of water.

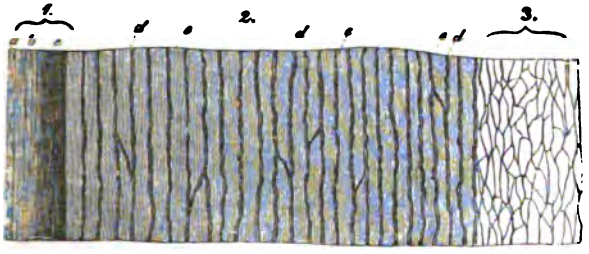
The outer coat consists of connective tissue with elongated nuclei and fine elastic fibres, and is nearly as thick as, or even thicker than the middle coat.

In the *smallest* arteries, the outer coat gradually ceases to contain elastic tissue, consisting merely of areolar tissue and the nuclei; this gradually loses its fibrous character, next becoming homogeneous, and finally a thin perfectly structureless membrane, and disappearing. In the same manner the middle coat gradually loses its layers of muscular fibres, until these and the fibres themselves ultimately vanish. On tracing the smaller arteries downwards, the inner coat is first found to lose its elastic fibres; and at last the epithelial cells cease to be isolable, all that can be distinguished consisting of their closely aggregated nuclei; but by maceration in very dilute solution of nitrate of silver, the lines of demarcation of the cell-walls are rendered beautifully distinct.

In *moderate-sized* arteries the middle coat increases in thickness, but, in addition to a larger number of muscular layers, fine elastic fibres in open networks are added, at first running somewhat irregularly through the muscular elements, and in the larger vessels of this category mixed with areolar tissue and here and there forming layers alternating with those of the muscular fibres. The inner coat sometimes contains between its elastic layer and the epithelium several other layers, forming, with fine networks of elastic tissue more externally situated in homogeneous granular or fibrillar areolar tissue, a strong middle layer, the elements of which are longitudinal. The outer coat in these vessels contains more elastic tissue, in the form of laminæ.

In the *largest arteries*, the epithelial cells of the inner coat are not so elongated, and the inner coat consists principally of layers of a homogeneous, striated, or even distinctly fibrillar substance, agreeing with areolar tissue, traversed by finer and coarser longitudinal networks of elastic tissue. Immediately beneath the epithelium the networks or elastic fibres are either very fine, or are replaced by one or more *striated layers*, which, when nucleated, often appear as if composed of fused epithelial cells, and when homogeneous resemble pale elastic membranes. The middle coat contains, as a new element, elastic membranes or plates, as many as 50 or 60, which, except in their transverse direction, resemble the elastic inner coat, sometimes forming the densest networks of elastic fibres, at others fenestrated membranes. These layers alternate with those of the muscular fibres traversed by areolar tissue and networks of elastic tissue. The muscular layer of the middle coat is less developed, its cells smaller and less regularly and perfectly formed.

Fig. 36.



Magnified 30 diameters.

Transverse section of the human aorta below the superior mesenteric artery, after acetic acid. 1. Inner coat: *a*, epithelium; *b*, striated layers; *c*, elastic layers. 2. Middle coat: *d*, its elastic layers; *e*, the muscular and areolar tissues. 3. Outer coat with its network of elastic tissue.

The outer coat is relatively and absolutely thinner than that in the smaller; but the structure is the same, except that its inner elastic layer is much less developed.

In some of the larger arteries of man, as the axillary and popliteal, and the mesenteric arteries of other mammals, the internal coat contains unstriped muscular fibres. This is the case also with the outer coat of the larger arteries in animals, but not in man.

All except the smallest arteries are furnished with nutrient blood-vessels, the *vasa vasorum*; these ramify principally in the outer coat, in the larger ones extending into the middle coat. They also receive branches of the sympathetic and spinal nerves.

Transverse sections of the arteries are best made with the freezing section-cutter or microtome. The epithelial cells require the use of solution of nitrate of silver.

The most important pathological changes to which the arteries are subject, consist of the deposition of fat in their substance (fatty degeneration) and of atheromatous matter. These will be noticed under FATTY DEGENERATION and ATHEROMA. See VESSELS.

BIBL. Henle, *Allg. An.*; Kölliker, *Gewebelehre*; Wedl, *Path. Hist.*; Rokitansky, *Krankh. d. Art.*; Frey, *Histologie*, 1881; Eberth, *Stricker's Handbuch*, v. p. 190; Rutherford, *Hist.* p. 100; Cohnheim, *Pathol.* 1878, p. 168.

ARTHO'NIA, Ach.—A genus of Lichenaceous Lichens, tribe Graphidei.

Char. Thallus thin or subepidermal and evanescent; apothecia dark, innately sessile; asci pyriform; spores 4–8, septate, upper cell larger; no paraphyses.

32 species, some common; on trees, holly, ash, oak &c.

BIBL. Leighton, *Lich. Flora*, 1879, p. 414.

ARTHRIN'IUM, Kze.—A genus of Dematiei (Hyphomycetous Fungi), of which one species has been found in Britain, growing upon dead leaves of *Eriophorum angustifolium*.

A. sporophlœum, Kze. Filaments elongated, tufted, often not more than 1-50″ long, but frequently confluent in a linear form, with a kind of velvety surface; spores numerous, angular, or like a double cone, attached in whorls at the joints of the filaments.

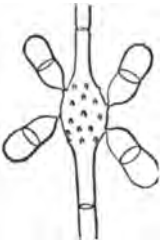
BIBL. Berkeley, *Ann. N. H.* 1838, i. p. 436; *Torula Eriophori*, Berk. *Engl. Fl.* v. pp. 2, 359; Fries, *Sum. Veg.* p. 502.

ARTHROBO'TRYS, Corda.—A genus of Mucedines (Hyphomycetous Fungi) bearing elegant nodular groups of septate spores. No species is yet recorded in Britain. Corda describes one species, *A. superba* (fig. 37); in this the spores are about 1-1500″ long. Fresenius describes another, *A. oligospora*, perhaps not distinct, which has the erect filaments about 1-50″ high, solitary,

not in tufts, and mostly with only one group of spores; these are pear-shaped, 1-700″ long, and have the septum below the middle: it was found on damp wood, fruit and earth, in a fungus-bed.

Fig. 37.

Fig. 38.



Arthrobotrys superba.

37. Fertile filament with many groups of spores. Magnified 200 diameters.
38. Fertile articulation of ditto, with most of the spores detached from the spine-like processes on which they are borne. Magnified 400 diameters.

Bibl. Corda, *Schimmelb.* p. 43, t. 21; Fresenius, *Beitr. zur Myc.*, Heft i. p. 18, pl. 3. figs. 1–8.

ARTHROBO'TRYUM.—A genus of Mucedines (Hyphomycetous Fungi), proposed by Cesati, characterized by a stem composed of jointed threads, bearing above large jointed radiating spores, so as to form a little head. They are beautiful microscopic objects. British species:—

A. atrum, B. & Br. On dead nettle-stems.

A. stilboideum, Ces. On a pollard-willow.

Bibl. Berkeley, *Out. Br. Fung.* p. 342; *Hedwigia*, tab. 4. fig. 1.

ARTHROCLA'DIA, Duby.—A genus of Sporochnaceæ (Fucoid Algæ). *A. villosa*, Huds., is a rather rare British annual submarine species, growing in 4 to 5 fathoms water; bearing a curious pod-like nucleated fruit.

Bibl. Harvey, *Brit. Mar. Algæ*, 2d ed. p. 24, pl. 5 C.; *Phyc. Brit.* t. lxiv.; *Eng. Bot.* t. 546; Derbès and Solier, *Ann. d. Sc. Nat.* 3 sér. xiv. p. 33, figs. 18–20.

ARTHRODES'MUS, Ehr.—A genus of Desmidiaceæ.

Char. Cells single, compressed, constricted in the middle; segments entire, with a single spine on each side.

A. convergens. Segments elliptic (Pl. 14. fig. 27); length 1-598 to 1-539″.

A. incus, Bréb. Segments with truncated ends; length 1-1103″.

A. minutus, Kütz. (Pl. 18. fig. 9).

A. truncatus, Ehr.

A. subulatus.

Other species.

Bibl. Ralfs, *Brit. Desmid.* pp. 117, 200; Kützing, *Sp. Alg.* p. 176; Ehrenberg, *Infus.* p. 158; Rabenhorst, *Fl. Alg.* iii. p. 225.

ARTHROGY'RA, Ehr.—An obscure genus of Diatomaceæ.

A. guatemalensis (Pl. 51. fig. 8). Filament straight.

A. semilunaris. Filament curved. Both in Guatemala earth.

Bibl. Ehrenberg, *Mikrogeologie*, pl. 33.

ARTHROMI'TUS, Leidy.—Described as a genus of the Leptothriceæ of Kützing (Algæ Confervoideæ). Two species, *A. cristatus* and *A. nitidus*, were found in the intestinal canal of *Iulus marginatus*, a kind of millipede. These objects appear to have been imperfect forms of some filamentous Fungus. See Parasites.

Bibl. Leidy, *Proc. Ac. Philadelphia*, iv. p. 225, 1849 (*Ann. N. H.* 2nd ser. v. p. 74).

ARTHRONE'MA, Hassall.—A genus of Oscillatoriaceæ (Confervoid Algæ).

A. cirrhosum (Pl. 8. fig. 20). Filaments of considerable size, striæ close, evident. Tufts widely spreading, filaments floating in bundles. In lakes at Lismore Island.

Bibl. Hassall, *Brit. Algæ*, p. 238; Rabenhorst, *Fl. Alg.* ii. p. 267.

ARTHROSI'PHON, Kützing. See Petalonema.

ARTICULI'NA, D'Orb.—Very narrow varieties of *Vertebralina*, which commence with a Milioloid (Triloculina) growth, and proceed with straight moniliform chambers, were separated by D'Orbigny under this name. Recent and fossil.

Articulina gibberula (Pl. 23. fig. 9 *a b*).

Bibl. D'Orbigny, *Ann. Sc. N.* vii. 300; Carpenter, *Intr. For.* 73.

ARTOTRO'GUS, Mont.—A genus of Sepedoniei (Hyphomycetous Fungi) containing one species, growing and fructifying in the intercellular passages of germinating potatoes. This genus is supposed by Berkeley to be founded on a secondary form of fruit of some mould; probably of *Peronospora infestans.* See Peronospora.

A. hydnosporus, Mont. Berkeley, *Jn.*

Horticult. Soc. i. p. 3, pl. 4. figs. 27–29; *Crypt. Bot.* p. 247; De Bary and Woronin, *Beit.* iv.

ARTOTRO'GUS, Boeck.—A genus of Entomostraca, Ord. Copepoda. Four British species; marine, living in the branchial sacs of *Ascidiæ*, or on the integument of marine Invertebrata.

BIBL. Brady, *Copepoda* (*Ray Soc.*), iii. p. 59.

ARUM, L.—A genus of Araceæ (Flow. Plants). *Arum maculatum*, the common Cuckoo-pint, has a tuberous rhizome in which is produced much starch. This starch is extracted in the same way as Arrow-root starch is from the rhizomes of Marantaceæ &c., and is called Portland Arrow-root (Pl. 46. fig. 11). See STARCH.

AS'CARIS.—A genus of Entozoa, of the order Cœlelmintha and family Nematoidea.

Char. Body cylindrical, narrowed at each end; head furnished with three tubercles or valves; mouth terminal, situated between the three tubercles; male with one or two spicula.

The species are very numerous, occurring in all the classes of the Vertebrata and doubtfully in Insects. They are most commonly found in the alimentary canal. We shall only notice the species met with in man.

A. lumbricoides. The common round worm. Inhabits the human small intestine; sometimes found also in that of the ass, wild-boar, pig, and ox. Varies in length from 3 to 15"; is of a whitish colour; the head distinct, with the three valves (Pl. 21. fig. 9) finely denticulated on their inner border, and each furnished near the summit with a slightly projecting papilla. Female larger and more common than the male. Spicula two, equal.

The recent ova are surrounded by an albuminous layer, the surface being studded with numerous projecting tubercles.

A. vermicularis (*Oxyuris verm.*). The human thread-worm. Found usually in the rectum. White; head frequently appearing winged, or exhibiting two lateral vesicular expansions (Pl. 21. fig. 8 *a*), produced by endosmosis. Mouth round when contracted, exhibiting the three lobes when expanded. Œsophagus (*e*) containing a triquetrous canal, and separated by a constriction from the spherical stomach (*d*). Length, female 3 to 4-10 of an inch; male shorter, with the tail spirally coiled, much more rarely met with. Anus (*g*) about 1-8 from the end of the body; spiculum single, with an appendage. Uterus consisting of two lobes (*h*) (ovaries); oviduct (*k*) opening externally near the middle of the body.

A. mystax (*alata*, Bell), 2 to 3 inches long, as broad as a crow-quill; common in the cat, occasional in the human body.

A. nigrovenosa, with the intestine black, is found in the lungs of the frog and toad; and parthenogenesis is supposed to occur. The females live in the lungs. The young pass into damp earth or mud, where they grow into sexual forms also producing embryos, which do not arrive at sexual maturity until they reach the lungs. No males are found in the lungs.

BIBL. Dujardin, *Helminthes*; Leuckart, *Mensch. Parasit.* ii. p. 153; Downe, *Mn. Mic. Jn.* 1871, v. p. 55 (*A. lumbr.*); Cobbold, *Entozoa*, 1879, p. 243; Duj. *Helm.* p. 178; Leuckart, *Paras.*, 1879, p. 128.

ASCHEMONEL'LA, Brady.—One of the branching Arenaceous Foraminifera. The chambers inflated, with 2 or more tubulated apertures, any of which may produce a new chamber.

BIBL. H. B. Brady, *Qu. Jn. Mic.* 1879, xix. p. 44.

ASCIDIA, Bast.—A genus of Tunicate Mollusca, of the family Ascidiadæ.

Several British species. See ASCIDIADÆ.

ASCIDIADÆ.—A family of Tunicate Mollusca.

Distinguished by their being single, usually fixed (to foreign bodies, as seaweeds, shells, &c.), and the attachment of the mantle to the test at the orifices only.

Irregularly shaped, from half to several inches long, often incrusted with stones and shells, &c.; with two orifices, one branchial and pharyngeal, the other anal. British genera:

Ascidia, Bast. Test leathery; branchial orifice eight-lobed, anal six-lobed, both circular; branchial sac not plaited.

Molgula, Forbes. Globose, attached or free; test membranous, usually covered with foreign matters; branchial orifice six-lobed, anal four-lobed, both on contractile naked tubes.

Cynthia, Sav. Sessile; test leathery; branchial sac plaited longitudinally; both orifices four-sided.

BIBL. Forbes and Hanley, *Brit. Moll.* i. p. 29; Gosse, *Mar. Zool.* ii. p. 35; Pascoe, *Zool.* 1880, p. 171.

ASCIDIC'OLA, Thorell.—A genus of Entomostraca, Ord. Copepoda. 1 species, marine.

BIBL. Brady, *Copepoda* (*Ray Soc.*), i. p. 145.

ASCLEPIADA'CEÆ.—A family of Dicotyledonous flowering plants, presenting some remarkable characters in the pollen (see POLLEN). The stems of some of these plants contain very tenacious fibres, which have been used for economical purposes (see FIBRES, vegetable).

ASCOB'OLUS.—A genus of Helvellacei; distinguished from *Peziza* by the asci being projected from the hymenium at maturity. *Ascobolus furfuraceus* is common on cowdung; but there are numerous other British species. The sporidia are often beautiful microscopic objects (Cooke, *Seemann's Jn. Bot.*, May 1864).

ASCOCOC'CUS, Billr.—A genus (form) of *Coccobacteria septica*, consisting of very minute colourless globules, closely united into globular or oval families, irregularly lobed, surrounded by a thick gelatinous envelope, forming a soft, flocculent, easily disintegrated membrane. See COCCOBACTERIA.

ASCOGLE'NA, Stein.—A genus of Flagellate Infusoria.

Char. Those of *Euglena*, enclosed in and fixed by the base to a flask-shaped lorica.

A. vaginicola. Green, with eye-spot; in fresh water.

BIBL. Kent, *Inf.* p. 393 (fig.).

ASCOMY'CES.—A genus of Ascomycetous Fungi, changed by some botanists, without reason, into *Exoascus*, characterized by the absence of any receptacle, the asci forming a thin pulverulent stratum. All the species are parasitic on living leaves or young shoots. It is the lowest form to which Ascomycetes can be reduced. British species:

A. bullatus. On pear-leaves.

A. deformans. On peach-leaves, producing a form of blister; and on young plums, forming what are called bag-plums, in which the stone is not developed.

A. trientalis. On leaves of *T. europæa.*

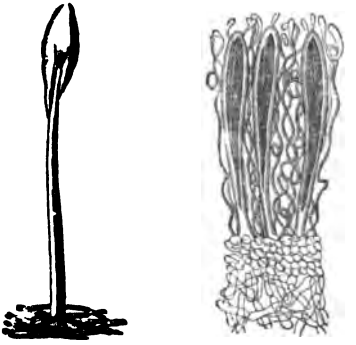
A. juglandis. On walnut-leaves.

A. carnosa. On *Rhododendron ferrugineum*, producing large gall-like excrescences.

BIBL. Berkeley, *Jn. Hort. Soc.* vol. ix. p. 48; *Br. Fung.* p. 376.

ASCOMYCE'TES.—An order of Fungi characterized by producing the spores in tubular sacs (*asci* or *thecæ*), frequently intermixed with empty filiform sacs (*paraphyses*) (fig. 40), and hence bearing a near relation to the Lichens, which, indeed, are included under this order by some botanists; but the existence of green colouring-matter in the cells, and of *gonidia* or brood-cells, in the Lichens, forbids such an association. The Ascomycetes differ much in external form, and approach in this particular several tribes belonging to the other orders: thus the Tuberacei are very much like many of the Gasteromycetes, the Helvellacei like

Fig. 39. Fig. 40.

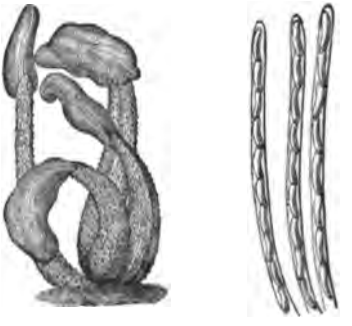


Spathulea flavida.

Fig. 39. Entire plant (reduced).
Fig. 40. Highly magnified section of fructification, showing asci and paraphyses arising from the hymenium.

some Hymenomycetes, &c., differing chiefly in the mode of the production of the sporidia (figs. 39–42).

Fig. 41. Fig. 42.



Leotia geoglossoides.

Fig. 41. Group of plants (reduced).
Fig. 42. Highly magnified asci with spores.

The Onygenei are little Fungi growing on dead animal substances, feathers, horn, &c.,

and have a flocculent mycelium, bearing little columnar bodies terminating in a thickened head—the sporange, which is a kind of hood falling off at maturity. The sporiferous structure, loosely filling up the hood, is composed of interlacing branched filaments, bearing at their free ends globular cells (*asci* or *thecæ*) filled with spores.

The Perisporiacei are likewise very simple, consisting of parasitical Fungi growing upon the leaves of trees or herbaceous plants. They have a flocculent mycelium, often radiating from a centre, where is found a membranous, sac-like, globular conceptacle, containing sometimes a definite, sometimes an indefinite number of clavate sacs or *asci*, alone or mingled with paraphyses, and containing ovate spores. The conceptacle bursts either regularly or irregularly at the summit.

The Sphæriacei have the conceptacles more developed, either single, or associated on a common receptacle, and consisting of a firm capsular structure, lined with *asci*, and opening at the apex by a regular pore in the form of a papilla or beak when mature.

The Phacidiacei differ chiefly in the dehiscence by slits, either single or longitudinal, or several and parallel or stellate, or circular so as to detach a lid; most of these have the sporanges collected on a common receptacle, either of horny or fleshy consistence.

In these two families, and in Helvellacei, Coniomycetous forms of spore are found upon the same receptacle, either contemporaneously or at different stages of development. Attention is directed to this subject under the head of that order; and more will be found under Sphæria, Tympanis, Rhytisma, Dothidea, Cordiceps, &c.

The true Tuberacei are Ascomycetous representatives of the Hypogæous Gasteromycetes, being subterraneous, solid, globular or lobed bodies, of fleshy consistence, the Truffle being a well-known example. The organization of the Tuberacei is analogous in all cases, but the structures differently arranged. They all have an inconspicuous flocculent mycelium, from which arises the solid sporange. The sporange exhibits, when cut across, an outer tough coat (*peridium*), enclosing a fleshy structure excavated with sinuous cavities giving it a marbled appearance. These sinuous cavities are produced by the convolutions of the fructifying layer, which is folded and reflected backwards and forwards, leaving interstices which are lined with the *asci* or spore-sacs containing four or eight spores. The degree of complexity of the lacunose mass differs in different genera, being in some simple, in others very complicated.

The fructification of the Helvellacei varies much in form, the simpler resembling closely some of the Phacidiacei: some kinds are minute fleshy cups lined with asci forming a superficial layer, as in *Propolis*; or they are large fleshy cups, often raised on a stalk (*Peziza*), these cups being closed at first, but opening widely afterwards. In the *Helvellæ*, the cup is converted into a stalked mitre-shaped body clothed above with *asci*. Others are of columnar form, thickened at the summit, which is clothed with the asci, as if a cup-shaped receptacle had been turned down over it (*Spathulea*, fig. 39)—this thickened head becoming more considerable and excavated into little pits in *Morchella*. These plants are mostly found on the ground or decaying vegetable substances, in damp places, and are frequently of gelatinous consistence.

If a *Peziza*, *Morchella*, *Rhytisma acerinum*, or similar Fungus, in its last stage of development, is kept shut up in a bottle for several hours, and then gently taken out, the contact of the external air causes an immediate and abundant explosion of spores, which may be collected on slips of glass for microscopic examination. If care is taken in the experiment, it will be found that a considerable quantity of a colourless liquid is expelled with the spores, which liquid contains minute molecules, and evaporates very rapidly, leaving more or less apparent spots on the glass. See Sphæria.

Synopsis of the Families.

Helvellacei. Fruit fleshy, of various forms, ultimately expanded, clavate, capitate, stalked, mitre-shaped, cup-shaped or bell-shaped, the upper surface clothed by elongated sacs (asci), each containing eight simple or septate spores.

Tuberacei. Fruit (subterraneous) globular, with an adherent peridium; solid and fleshy within, and excavated sinuously into numerous cavities clothed by asci containing four or eight spores; the internal mass drying up or becoming pulverulent or floccose when mature.

Phacidiacei. Fruit fleshy, simple or branched, more or less cup-shaped in the sporiferous region, which opens widely or by a slit when mature, and exposes a

cavity lined with elongated asci mixed with paraphyses.

SPHÆRIACEI. Fruit usually forming a common, often horny, receptacle, in which are excavated conceptacle, lined with asci, opening by a terminal pore.

PERISPORIACEI. Common receptacle floccose, radiating from a centre, bearing conceptacles free or surrounded by filaments, opening by a terminal pore, with asci attached at the base filled with simple ovate spores.

ONYGENEI. Mycelium floccose, bearing capitate, stalked sporanges, which open by a circular slit at the base, causing the upper part to fall off like a cap; exposing a fructifying mass composed of interlacing branched filaments, bearing globular asci at the free extremities of the branches.

BIBL. See under the heads of the Families.

ASCOPH'ORA, Tode. See MUCOR.

ASCOT'RICHA, Berk.—A genus of Perisporiacei (Ascomycetous Fungi), containing one species.

A. chartarum, a kind of mildew growing on paper, forming a brownish, angularly and dichotomously branched mycelium, from which arise globose, black, hairy peridia containing linear asci, each containing a single row of chocolate-coloured spores. Peridia from 1-20 to 1-30″ in diameter.

BIBL. Berkeley, *Ann. N. H.* 1838, i. 257, pl. 7. fig. 8.

AS'CUS.—The term applied to the cylindrical globose or clavate tubular sac forming the parent cell of the sporidia in the Ascomycetous Fungi. It is frequently called a *theca* also (figs. 40 and 42). Asci consist of a double membrane, the inner often visibly projecting when the ascus is broken across. A little lid is frequently separated from the apex when the sporidia are discharged, as in *Ascobolus*, in which genus the asci are shot out from the common hymenium. See ASCOMYCETES.

BIBL. *Mag. Zool. & Bot.* vol. ii. p. 222; *Pringsh. Jahrb.* Bd. i. p. 189; Cooke, *Handbook.*

ASEL'LUS, Geoffroy (the water woodlouse).—A genus of Crustacea, of the family Isopoda.

Char. Antennæ four, outer much longer than the inner ones; legs shorter than the body, the first pair not chelate; two posterior projecting bifurcate abdominal appendages.

A. vulgaris (Pl. 18. fig. 13). Length 1-4 to 1-2″ or more. This animal is particularly interesting to the microscopist, on account of its forming the most readily procurable object for examining the dorsal vessel and circulating liquid in motion. It is found in almost all stagnant waters. The currents of the circulating liquid, with the colourless corpuscles, are readily seen streaming through every part of the body. Beneath the large scutiform joint of the body (the abdomen), are three flattened branchial false legs or gills on each side, covered by two jointed gill-covers; these are in almost constant motion during life.

BIBL. Desmarest, *Consid. Gén. s. l. Crustacés*; Treviranus, *Vermischte Schriften*, i.; M.-Edwards, *Crustacés*, iii. (*Suites à Buffon*).

ASPERGIL'LUS, Micheli.—A genus of Mucedines (Hyphomycetous Fungi) forming common mould, such as the blue mould of cheese, *A. glaucus*. The chains of spores arise from a more or less globular head at the apex of the fertile filaments (fig. 43). It is often stated that the heads of spores are originally enclosed in a peridium; according to our observations this is not the case; the spores bud out from the capitular cell, which enlarges very much during the formation of the head of spores; and when these have been detached, the head is left bare, but covered with short spiny processes (the points of attachment of the chains of spores), and then looks something like a young peridium of *Mucor*. *Aspergillus* has been found to produce a secondary form of fruit, being that forming the subject of the genus EUROTIUM. British species:

Fig. 43.

Aspergillus glaucus.
A fertile filament with chains of spores on a globular head.
Magnified 50 diameters.

* *Fertile filaments simple.*

A. glaucus, Link. Sporidia globose, variable, white to glaucous, close (*A. candidus*, Link) or lax. Heads about 1-100″ in diameter when mature. On cheese, lard, bread, &c., very common (fig. 43). It has been found also in the lungs and air-cavities of birds, *Mucor glaucus*, L.

A. roseus, Lk. Sporidia globose, very small, rose-red; fertile filaments not septate. On damp paper, lint, carpet, &c.

A. aureus, Berk. Sporidia large, elliptical, thinly scattered, golden-yellow; fertile filaments without septa. On bark. Now referred with *A. aurantiacus*, from which it scarcely differs, to the genus *Rhinotrichum*.

A. aurantiacus, Berk. Sporidia oval, the lowest of the chain much larger, mycelium rusty orange, the heads often proliferous, so as to produce a complicated mass. On bark. *Ann. N. H.* vi. p. 436, pl. xiii. fig. 22. *Nematogonium aurantiacum*, Desmaz. *Ann. des Sc. Nat.* 2 sér. ii. p. 69, pl. 2. fig. 1.

** *Fertile filaments branched.*

A. maximus, Lk. Sporidia very large, at length yellow-brown, mycelium a fleecy mass of the same colour; fertile filaments dichotomous, clavate above. On decaying Fungi.

A. mollis, Berk. Sporidia large, subglobose, white, mycelium white; fertile filaments dichotomous, standing in minute, scattered, white bundles.

A. virens, Lk. Sporidia, like the filaments, greenish; tufts of fertile filaments rather dense, entangled, suberect. On decaying fungi and other bodies.

A. alternatus, Berk. Sporidia grey-black, subtruncate; fertile plants branched alternately in a zigzag manner, erect or decumbent, forming extremely minute orbicular patches on damp paper. *Ann. N. H.* 1838, i. p. 262, pl. 8. f. 11.

A. dubius, Corda, would appear to differ generically from the above. Mr. Berkeley states that its capitular cells bear linear processes, each surmounted by four sterigmata, on which are attached the chains of spores. On dung. Corda, *Ic.* ii. t. 11. fig. 77.

Bibl. Berkeley, *Hooker's Br. Fl.* ii. part 2, p. 349; *Ann. N. H.* i. 262, vi. 436, 2nd ser. vii. 100; *Crypt. Bot.* p. 298; Fries, *Syst. Mycolog.* iii. 383; Corda, *Ic. Fung.*; Robin, *Parasites*, p. 515.

ASPEROCOC'CUS, Lamour.—A genus of Dictyotaceæ (Fucoid Algæ), of which three species are found on the British coast. The fructification consists of groups of sporanges (commonly called spores), intermixed with paraphyses, scattered over the whole surface of the frond. When mature these sporanges discharge zoospores.

Bibl. Harvey, *Mar. Algæ*, 2nd ed. p. 42, pl. 8 C.; *Phyc. Brit.* t. xi., lxxii. and cxciv.; Thuret, *Ann. Sc. Nat.* 3 sér. xiv. p. 238; Derbès and Solier, *ibid.* p. 268, pl. 34. fig. 11.

Fig. 44.

Fig. 45.

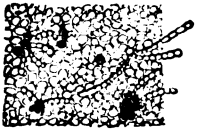
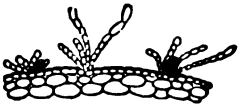


Fig. 46.



Asperococcus Turneri, Dillw.
Fig. 44. Fronds, reduced to one third.
Fig. 45. Fragment of ditto, magnified 50 diameters.
Fig. 46. A section at right angles to fig. 45, showing the sporanges and paraphyses, magnified 50 diameters.

ASPIDIE'Æ.—A family of Polypodiaceous Ferns, with indusiate sori. Genera:

Didymochlæna. Sori elliptical, intramarginal, terminal on a veinlet; indusium oblong-elliptical, emarginate at base, attached to the linear receptacle, free at edge.

Aspidium. Sori rounded, dorsal or terminal; indusium orbicular, peltate.

Nephrodium. Sori rounded, dorsal or terminal; indusium cordato-reniform, attached by the sinus.

Nephrolepis. Sori round, arising from the apex of the upper branch of a vein, generally near the edge; indusium roundish or reniform; veins free.

Oleandra. Sori round, in a row near the base of the compact free veinlets; indusium reniform.

Fadyenia. Sori oblong, biserial, terminating free veinlets; indusium large, subreniform, attached by the centre, free at margin.

Bibl. See Ferns.

ASPIDIS'CA, Ehr.—A genus of Infusoria, of the family Aspidiscina.

Char. That of the family.

A. (*Trichoda*, Müll.) *lynceus* (Pl. 30. fig. 15 *a*, under view). Carapace suborbicular, truncated posteriorly, uncinate anteriorly aquatic, among *Confervæ*, &c.; length 1-1100 to 1-560″.

A. denticulata (Pl. 30. fig. 15 *b*, side view). Carapace suborbicular, rounded at the ends, truncate and denticulate on the left side; aquatic; length 1-560″. See Oxytricha.

Bibl. Ehrenb. *Infus.*; Duj. *Infus.*; Stein, *Infusionsthiere* &c.

ASPIDISCI'NA, Ehr.—A family of Infusoria.

Char. A carapace present in the form of a transparent flattened shield, projecting beyond the mouth in front; flexible bristles on the ventral surface of the body, with delicate oral cilia.

Ehrenberg describes an alimentary canal, the inferior orifice of which alone is terminal. Hence they correspond to *Euplotes*, with the excrementitial orifice terminal.

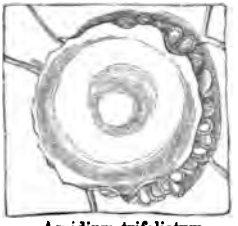
Dujardin places them among his *Coccudinæ*.

The setæ, styles, or cirri serve for climbing, whilst by the cilia the animals are enabled to swim.

This family should not be retained, but the single genus of which it is constituted, *Aspidisca*, referred to the Euplota.

ASPID'IUM, Schott.—A genus of Aspi-

Fig. 47.



Aspidium trifoliatum.
An indusium covering a sorus.

dieæ (Polypodiaceous Ferns), in its old sense including many of our native species,

Fig. 48.

Aspidium trifoliatum.
Side view, cut through perpendicularly.
Magnified 25 diameters.

but now broken up into subdivisions, raised to the rank of genera.

A. Lonchitis and *aculeatum*, including *lobatum* and *angulare* as varieties, are British.

ASPLANCH'NA, Gosse.—A genus of Rotatoria, of the family Hydatinæa.

Char. Foot, intestine, and anus absent; eye-spots (1 to 3) and mandibles present; sexes separate.

A. Brightwellii (*Notommata syrinx*, Ehr. ?). Female: jaws with a single tooth; eye-spot single; tremulous bodies attached to an extended filament; aquatic; length 1-24″. Male: jaws, pharynx, and stomach absent; body truncate; length 1-40″.

A. priodonta (Pl. 43. fig. 7, female). 3 eye-spots; tremulous bodies attached to a tortuous filament; aquatic; length—female 1-48″, male 1-110″; jaws of female serrated (7 *b*).

Bibl. Brightwell, *Ann. N. H.* ser. 2, ii. p. 153, pl. 6; Dalrymple, *Tr. Roy. Soc.* 1849, and *Ann. N. H.* 1849, iii. p. 618; Gosse, *Ann. N. H.* 1850, vi. p. 18, viii. p. 197.

ASPLENIE'Æ.—A family of Polypodiaceous Ferns, with indusiate sori. Genera:

Asplenium. Sori dorsal or submarginal, linear or oblong; indusium similar in shape, straight or curved, single or double, plane or tumid, bursting along the outer edge.

Allantodia. Sori dorsal, linear-oblong, attached to the primary veins; indusium of the same shape, and entirely enclosing them, bursting in an irregular line down to the centre.

Actiniopteris. Sori linear elongate, submarginal; indusium of the same shape, folded over them, placed one on each side of the narrow segments of the frond, and opening towards the midrib. Frond flabellate.

Bibl. See Ferns.

ASPLE'NIUM, Presl, *Spleen-wort.*—A well-known genus of Aspleniæ (Polypodiaceous Ferns), containing a number of indigenous species.

ASSILI'NA, D'Orb.—A variety of *Nummulina* (grouped as a subgenus), in which the alar lobes are reduced to a minimum, and thereby the faces of the shell are left unthickened, except perhaps at their centres; and nearly or quite all the whorls are exposed. These shells are the *Nummulinæ explanatæ* of D'Archiac and Haime. *Assilina exponens*, Sow., sp., is the best type of this subgenus of *Nummulina*. It abounds, with the more perfect type, in the older Tertiary strata of Switzerland and India.

Bibl. D'Orbigny, *Ann. Sc. Nat.* vii. 296 (the Modèle 88 here referred to, however, is an *Operculina*); D'Archiac and J. Haime, *Foss. Ann. de l'Inde*; Parker and Jones, *Ann. N. H.* ser. 3, v. 110, and viii. 232.

ASTA'SIA, Ehr.—A genus of Infusoria of the family Astasiæa.

Char. Unattached, no eye-spot. Flagel-

liform filament single, arising suddenly from the anterior part of the body, or from a more or less deep notch in it; oral aperture very extensile (*Kent*), leading to a long œsophagus.

Dujardin forms an unnecessary genus, *Peranema*, to contain those species in which the filament arises from the gradually narrowed anterior extremity of the body.

A. hæmatodes, E. (Pl. 30. fig. 16). Fusiform, tail very short; at first green, then red; length 1-380″.

The flagelliform filament was absent in the specimens represented in the figure. The substance of the body was insoluble in caustic potash, even when heated to boiling, merely becoming swollen. It exhibited numerous vacuoles, which in some of the organisms were filled with green grains of chlorophyll. The colour arose from distinct granules of pigment, scattered through the colourless substance; when treated with solution of iodine and then sulphuric acid, the *Astasiæ* became spherical, and were coloured blue, bluish green, and purplish blue, the purple tint apparently indicating the presence of cellulose. It was, however, afterwards found that these colours were produced by the acid alone.

This curious organism colours the water of ponds &c. blood-red.

A. limpida, D. (Pl. 30. fig. 17). Fusiform, colourless; length 1-550″.

There are other species; but they are ill-defined. *A. nivalis*, Shuttleworth, found in red snow, would appear to be an active form of *Protococcus nivalis*.

Bibl. See Astasiæa; also Shuttleworth, *Bibl. de Genève*, Feb. 1840; Kent, *Infus.* p. 375.

ASTASLÆ'A, Ehr.—A family of Flagellate Infusoria.

Char. Body of spontaneously variable form, mostly with one or more flagelliform filaments. Insoluble in solution of caustic potash.

This family corresponds nearly to the Euglenia of Dujardin, who asserts the existence of a contractile integument. Form of the body variable, sometimes becoming spherical, at others cylindrical, fusiform, &c., and exhibiting a head or tail-like process, or both. The Astasiæa are distinguished from the Amœbæa by the absence of the irregular processes sent out by the latter from all parts of the body; and by the presence of a distinct mouth.

The forms included under the family thus characterized are still very imperfectly understood; and it is probable that some of them, separated generically by Ehrenberg, are only transitional conditions of others. Infusoria exactly resembling *Astasia hæmatodes* and *Euglena viridis* occur without the flagelliform filament; *Euglena* also occurs in a resting form, surrounded by a gelatinous envelope, like *Chlamidomonas*, and undergoes division into 4, 8, 16 or more new individuals in this state, so as to form irregular, floating Algoid patches. The green bodies make their escape from the gelatinous envelopes under certain circumstances, just in the same way as the zoospores escape from the cells of the Confervoid Algæ. This resting form also exhibits another character, especially in winter; the gelatinous envelope acquires a firm, dense, membranous coat over its periphery, like the resting spores of the Confervoids, and in some cases this coat is polygonal and marked with ridges &c. It is probable that the colour of the species is not constant, since it seems to depend upon similar substances to that of the Palmellaceæ, which are known positively to change from green to red, and *vice versa*, and even to fade into an almost colourless state when kept in the dark. These organisms still require much careful examination, not of isolated specimens, but by watching their developmental history constantly for extended periods and through different seasons. More is said on this subject under Protococcus.

The following Table gives the genera of Ehrenberg and Dujardin:—

Attached	*Colacium*, Ehr.
Unattached.	
Two eye-spots	*Distigma*, Ehr.
One flagelliform filament.	
One eye-spot.	
With a tail-like process	*Euglena*, Ehr.
Without „	*Amblyophis*, Ehr.
No eye-spot	*Astasia*, Ehr. (& *Peranema*, Duj.).
Two flagelliform filaments.	
Both alike.	
Animals green, with a red eye-spot	*Chlorogonium*, E.
Colourless, no eye-spot	*Zygoselmis*, Duj.
One anterior, the other trailing and retractile	*Heteronema*, Duj.
Several filaments	*Polyselmis*, Duj.

Bibl. Ehrenberg, *Inf.*; Dujardin, *Infus.*; Morren, *Rubéfact. d. Eaux*, Brux. 1841; Cohn, *Protococ. pluv.*, *Nova Acta Ac. L. C. N. C.* xxii. p. 397. (Abstr. *Ray Soc.*, *Bot.* 1853, p. 352.)

ASTATHE. See Primordial Utricle.

ASTERIGERI'NA, D'Orb.—A pseudogenus of Foraminifera, comprising species

of both *Rotalia* and *Discorbina*, that have star-like patterns on one face of the shell. In some *Rotaliæ* an astral arrangement of subsidiary chamberlets around the umbo is formed as in *Amphistegina*; and in several *Discorbinæ* the deep radiating sulci around the umbilicus are roofed over with distinct, more or less perfect plates of shell.

Bibl. Carpenter, *Intr. For.* 204, 213.

ASTERIONELLA, Hass.—A genus of Diatomaceæ (Cohort Fragilariæ).

Distinguished by the inflation of one or both ends of the frustules, and by the adherence of their adjacent angles into a stellate form.

Doubtless the frustules are originally parallel, forming a straight filament.

A. formosa (Pl. 18. fig. 14). Frustules 4–8; in the front view somewhat more enlarged at the attached than the free end. Aquatic; length 1-384″.

A. Ralfsii. Frustules linear; valves attenuated towards one end, constricted towards the other, which is rounded and capitate. Aquatic; length 1-555″.

A. Bleakeleyii. Frustules linear, enlarged at the base. Marine; length 1-454″.

2 other species.

Bibl. Hassall, *Micr. Exam. of London Water*; Smith, *Br. Diat.* ii. 81; Greville, *Ann. N. H.* 1865, xvi. p. 4; Rabenhorst, *Flor. Alg.* i. p. 141.

ASTERODIC'TYON, Ehr. (*Ber. d. Berl. Akad.* 1845). See Monactinus.

ASTERODIS'CUS, Johnson.—A genus of fossil Diatomaceæ, allied to *Asterolampra* and *Asteromphalos*; but distinguished by one septum dividing halfway from the centre, and proceeding to two of the compartments, the intermediate smooth ray being smaller than the others. 3 species; rays from 5 to 9.

Bibl. Johnson, *Silliman's Jn.* 1852, xiii. p. 33.

ASTEROLAM'PRA, Ehr.—A genus of fossil Diatomaceæ.

Char. Free; circular; central portion divided by thin septa, which do not reach the margin, but alternate with rays extending to the margin, unsupported by septa; fossil. Intermediate between *Actinocyclus* and *Actinoptychus*.

A. marylandica (Pl. 25. fig. 5). Marginal rays eight, septa eight; interstices between the rays exhibiting elegant curved series of dots; diam. 1-180″. Found fossil in Maryland.

Other species.

Bibl. Ehr. *Ber. Berl. Ak.* 1844, p. 73; Greville (*Monogr.*), *Mic. Tr.* 1860, p. 102, 1862, 41, 1863, 227, 1865, 99; Kützing, *Sp. Alg.* 129.

ASTERO'MA, D.C.—A genus of Sphæronemei (Stylosporous Fungi) growing upon leaves and stalks, forming very minute, slightly prominent coloured or black spots, more or less confluent, seated on more or less distinct radiating filaments. Fries separates part of the species under the name of *Actinonema*. Species:

A. reticulatum, D.C. *Dothidea reticulata*, Fr., Corda. On decaying leaves of *Convallaria*. Hooker, *Br. Fl.* ii. part 2. p. 288.

A. Ulmi, Klotsch. On elm-leaves. Hooker, *Br. Fl.* ii. part 2. p. 289.

A. Prunellæ, Purt. On green leaves of *Prunella vulgaris*. Hooker, *Br. Fl.* ii. part 2. p. 289.

A. Padi, Grev. On *Prunus Padus*. Hooker, *Brit. Fl.* ii. pt. 2. p. 289; Berkeley, *Ann. N. H.* vi. 364, pl. 11. fig. 4.

A. Rosæ, Lib. On rose-leaves. Libert, *Tr. Linn. Soc. Paris*, 1826; Berkeley, *Ann. N. H.* vi. p. 364, pl. 11. fig. 5.

A. labes, Berk. *Ann. N. H.* vi. 364. pl. 11. fig. 6.

A. Veronicæ, Desm. Berkeley, *Mag. Zool. & Bot.* i. p. 511.

Bibl. Fries, *Summa Veget. Scan.* 424.

ASTEROM'PHALOS, Ehr.—A genus of Diatomaceæ.

Resembles *Asterolampra*, except that two of the central septa are parallel, and one of the marginal rays absent or almost obliterated.

The species occur in the Antarctic ocean; the diameter of the valves lies between 1-900 and 1-47″. They are distinguished by the number and direction of the central rays.

A. Darwinii. Central rays five, flexuous.

A. Hookerii (Pl. 25. fig. 2). Central rays six, marginal five, straight.

A. Rossii. Rays six, inflexed.

A. Buchii. Rays six, straight.

A. Beaumontii. Rays seven, inflexed (Pl. 18. fig. 15).

A. Humboldtii. Rays eight, straight.

A. Cuvierii. Rays nine, straight.

A. Brookii. Rays ten.

Bibl. Ehr. *Ber. d. Berl. Akad.* 1844; Kützing, *Sp. Alg.* 129.

ASTEROPH'ORA, Dittm.—A genus of Sepedoniei (Hyphomycetous Fungi), composed of minute fibrous plants, growing parasitically upon dry blackened Agarics,

deriving their name from the angular, somewhat stellate spores; now shown by Tulasne to be the conidiiferous state of a species of *Hypomyces*. Two British species:

A. agaricoides, Fr. Stipe solid, 1″ high, 1‴ or more thick, villous, bearing a head, at first hemispherical, then plane, about 1-2″ wide, at first covered by a white fugacious tomentum, with lamellæ underneath; spores 6-angled. On decaying Agarics (*A. adustus, piperatus*), in autumn, gregarious. *A. lycoperdioides*, Dittm. *Sturm's Deutsch. Fl.*

A. lycoperdioides, Fr. Stipe 1″ high or obsolete; head hemispherical or globose, without lamellæ beneath; spores 5–6-angled. In similar situations, rather more common. *Agaricus lycoperdioides*, Sow.

Bibl. Hook. *Br. Fl.* ii. part 2. p. 322; Sowerby, *Fungi*, t. 279; Sturm, *Deutschl. Fl.* iii. t. 26; Bulliard, *Herb.* t. 166, 516, fig. 1; Tulasne, *Carpologia*, iii. p. 54.

ASTEROTHRIX, Ktz.—An obscure genus of Algæ.

Char. Filaments very minute, indistinctly jointed, greenish, very rigid, stellately branched, acutely cuspidate at each end, floating; *A. Pertyana* (Pl. 3. fig. 5).

3 species: fresh water.

Bibl. Kützing, *Phyc. Gen.* p. 200; Rabenhorst, *Flor. Alg.* iii. p. 391; Perty, *Kleinst. Lebensf.* p. 216.

ASTH'MATOS, Salisb.—A genus of Cilio-flagellate Infusoria.

Char. Free, rounded, with an anterior bundle of cilia, and a flagelliform filament.

A. ciliaris (Pl. 53. fig. 9). In the mucus of the eyes, nose, and throat, in catarrh and hay-fever; length 1-1200″. Probably the ciliated epithelium covering the mucous membranes of these passages.

Kent, *Inf.* p. 466.

AS'TOMUM, Hampe.—A genus of Bruchiaceæ (Acrocarpous Mosses), including some of the *Phasca* of Linnæus, &c.

A. subulatum, Hmp. = *Phascum subulatum*, L. (fig. 49).

A. alternifolium, Hmp. = *Ph. alternifolium*, Dicks, *Crypt.* (fig. 50).

A. nitidum, Hmp. = *Ph. axillare*, Dicks.

Bibl. Müller, *Syn. Muscor.*; Wilson, *Bryol. Brit.* p. 24.

ASTRORHI'ZA, Sandahl.—A relatively large Rhizopod, related to *Lituola*. Varying from sphæroidal to irregularly star-shaped, and having sometimes a disk ¼ inch broad, besides radii or digitated branches. Its test is arenaceous and thick, without any large aperture, the pseudopodia being extruded from between its constituent sand-grains.

Fig. 49.

Astomum subulatum. A leaf, showing the cellular structure. Magnified 40 diameters.

Fig. 50.

Astomum alternifolium. Section of sporange. Magnified 40 diameters.

Bibl. Sandahl, *Öfvers. Vet.-Akad. Förhandl.* 1857, p. 299; Carpenter, *Pr. Roy. Soc.* 1869, p. 289.

ASTROSI'GA, Kt.—A genus of Flagellate Infusoria. Resembling *Uvella*, but flagellum surrounded by a hyaline collar.

A. disjuncta: fresh water.

Bibl. Kent, *Inf.* p. 341.

ASTROTHE'LIUM, Eschw.—A genus of Lichenaceous Lichens.

A. parmularia. On young oaks, very rare.

Bibl. Leighton, *Lich.-Flora*, p. 499.

ATAX, Dugès.—A genus of Arachnida, of the order Acarina, and family Hydrachnea.

Char. Body ovoid; a genital fissure borbered by two plates, upon each of which are three transparent rounded tubercles; anterior coxæ posteriorly in contact in the median line, wedging the labium between them anteriorly; the two groups of posterior coxæ distant; fourth coxa very broad, in contact with the third throughout its whole length; palpi with the fourth joint very long, attenuate, slightly excavated towards the end to receive the fifth joint in a state of extreme flexion; fifth joint forming a pointed claw; mandibles consisting of a thick body cut off obliquely like the point of a pen posteriorly, truncate anteriorly, and terminated by a large, strong, and slightly curved claw; labium oval, concave and bifid.

Several species, of various brilliant colours.

A. histrionicus (*Hydrachna histrionica*,

Herm.) (Pl. 6. fig. 14). Body dark red, paler in front of the eyes, a square black spot in front of them; dorsally marked with longitudinal converging striæ; five black spots on the anterior portion of the ventral surface; palpi and legs blackish green.

The black spots are produced by the viscera indistinctly visible through the skin.

A. Bonzi is semitransparent, yellowish, with some brown; parasitic in the shell of the freshwater mussel.

Murray states that *Arrenurus viridis* is the male of *Atax histrionica*.

Bibl. Walckenaer, *Aptères*, iii. (Gervais); Hermann, *Mém. Aptérol.*; Dugès, *Ann. d. Sc. N.* 2 sér. i.; Koch, *Deutschl. Crust.*, &c.; Claparède, *Studien an Acariden* (*Ann. N. H.* l. 1871, 55); Murray, *Econ. Entom.* 154.

ATAXOPHRAG'MIUM, Reuss. — The Buliminæ with arenaceous shells come under this denomination.

Bibl. Reuss, *Sitz. Ak. Wien.* xliv. 383.

ATHERO'MA.—Atheromatous deposits consist of globules of oil of the most varied sizes, frequently exceedingly minute, mixed with albuminous matter in the form of amorphous masses or flakes and molecules, plates of cholesterine and granules of carbonate of lime.

ATHY'RIUM, Roth. — A subgenus of *Asplenium* (Polypodiaceous Ferns). To this belongs the lady-fern, *A. Filix-fœmina*, formerly known as an *Aspidium* and a *Lastræa*.

AT'OMA, or *Astoma*, Latr. = Trombidium, pt.

ATRAC'TIUM.—A supposed genus of Stilbacei (Hyphomycetous Fungi), characterized by its fusiform elongated spores, but now believed to be a state of some *Nectria*.

Bibl. Tulasne, *Carpologia*, iii. p. 104.

ATRACTOB'OLUS, Tode. — Formerly described as a genus of Nidulariacei (Gasteromycetous Fungi), is merely the egg of a *Raphignathus*.

ATRACTONE'MA, St. — A genus of Flagellate Infusoria.

Char. Free, fusiform, flagellum single; oral aperture connected with the contractile vesicle, nucleus central.

A. teres (Pl. 53. fig. 8). Fresh water.

Bibl. Kent, *Infus.* p. 373.

ATRAC'TYLIS, Wright.—A genus of marine Polypes, of the order Hydroida, and family Atractylidæ.

Char. Polypes naked, borne on a stolon, erect, funnel-shaped, with a conical proboscis, surrounded by a simple whorl of filiform tentacles.

A. arenosa. Surface sanded. On stones, and roots of *Laminaria*.

Bibl. Hincks, *Hydr. Polypes*, p. 87.

AT'RICHUM, Palis.—A genus of Mosses, forming a subdivision of Polytrichum.

Bibl. Wilson, *Bryol. Brit.* p. 202.

ATRO'PIA (Atropine). See Alkaloids.

AT'ROPOS, Leach.—A genus of Hymenopterous Insects, of the family Psocidæ (Termitidæ).

Characterized by the long setaceous antennæ, which have more than ten joints, the absence of wings, the eyes of moderate size, and the three-jointed tarsi.

A. pulsatorius (book-mite) is very common in dried collections of plants, old books, &c., which form its food. It is about 1-20″ long, of a dirty-white or yellowish colour; head oblong; joints of antennæ elegantly striated transversely; mandibles horny and toothed; abdomen oblong-ovate, depressed; posterior femora thickened.

The allied genus *Psocus* has the head broad, and the posterior margin of the fore wings with three or four cells. The species are found upon old palings, the bark of trees, &c.

Bibl. Westwood, *Entom. Text-book*, 368; id. *Introduct. &c.*, ii. 17 & 20.

AT'THEYA, West.—A genus of Diatomaceæ.

Char. Frustules compressed, annulate; valves elliptic lanceolate, with a median longitudinal line; angles spinous.

A. decora (Pl. 51. fig. 39). Druridge Bay.

Bibl. *Micr. Tr.* viii. p. 152.

ATTHEYEL'LA, Brady.—A genus of Copepodous Entomostraca, allied to *Canthocamptus*.

2 species; fr. water.

Bibl. Brady, *Copepoda* (*Ray Soc.*). ii. 58.

AUGITE. See Rocks.

AULACODIS'CUS. See Eupodiscus.

AULACOG'RAPHA, Leighton.—A genus of Graphideæ (Lichenaceous Lichens), founded on the species *Aulacographa* (*Opegrapha*) *elegans*, Sm., distinguished by the peculiar furrows of the proper margins surrounding the disks of the lirellæ. Grows on the bark of trees.

Bibl. Leighton, *Ann. N. H.* xiii. p. 389, pl. 7, 1854; *Lichen-Fl.* 427.

AULACOSI'RA. See Melosira.

AULIS'CUS, Ehr.—A genus of fossil Diatomaceæ.

Differs from *Eupodiscus* in the processes being more solid and less fragile, and in the markings of the valves consisting of wavy festooned striæ, in some resolvable into dots, in others not. But the genus seems unnecessary.

Eupodiscus sculptus (Pl. 16. fig. 31) would form a species of *Auliscus*.

Auliscus pruinosus, Pl. 18. fig. 60.

BIBL. Ehrenberg, *Ber. d. Berl. Ak.*; Bailey, *Smiths. Contrib.* 1854; Greville, (*Monogr.*), *Micr. Tr.* 1863, p. 36; *ibid.* (*new spec.*), 1863, p. 75; 1864, pp. 82, 88; 1865, p. 5; 1866, p. 6; Rabenhorst, *Flor. Alg.* p. 320.

AULOCOM'NIUM, Schwægr.—A genus of Mosses. See MNIUM.

AVAN'TURINE.—A mineral composed of silex, with numerous minute scales of mica interspersed through its substance, or traversed in all directions by minute fissures or cracks, giving it an elegant sparkling or iridescent appearance.

Artificial Avanturine consists of glass with numerous minute crystals of metallic copper distributed through it. These crystals are mostly in the form of triangular or hexagonal plates, the angles sometimes curiously prolonged or beaked.

It forms a beautiful microscopic object.

It was originally manufactured at Venice, and the process kept secret. But MM. Fremy and Clémandot have shown that it may be prepared by heating glass with protoxide of copper and iron scale (protoxide of iron); the latter reduces the protoxide of copper by combining with the oxygen so as to form the peroxide.

BIBL. Wöhler, *Chem. Gaz.* i.; Fremy and Clémandot, *l. c.* iv.

AVENEL'LA, Dalyell.—A genus of Infundibulate Polyzoa, of the suborder Cyclostomata, and family Vesiculariidæ.

Distinguished by the thread-like, nearly simple base; the large, scattered, solitary, slightly contracted and curved cells; and the 20 to 24 tentacles and small gizzard.

The single species, *A. Dalyellii* (*fusca*), brown, occurs matted with foreign matters; cells about 1-16″ long. On Sertulariæ, from deepish water.

BIBL. Dalyell, *Anim. of Scotland*, ii. 65; Gosse, *Mar. Zool.* ii. 21; Hincks, *Polyz.* 526.

AVICULA'RIA.—A term applied to the birds'-head processes of the Polyzoa. See POLYZOA.

AZOLLA, Kaulf.—A genus of Marsileaceæ or Rhizocarpeæ, consisting of a few species of small floating plants, occurring in Australia and throughout America. The mode of reproduction is evidently analogous to that of *Salvinia*; but its development has not yet been fully examined.

BIBL. R. Brown, *Flinders's Voyage*, ii. *App.* p. 611; Meyen, *Nova Acta*, xviii. p. 507; Griffith, *Calcutta Jn. of N. Hist.* v. p. 227; Mettenius, *Linnæa*, xx. p. 259, 1847 (*Ann. des Sc. Nat.* 3 sér. xi. p. 111).

B.

BACILLA'RIA, Gmelin.—A genus of Diatomaceæ.

Char. Frustules bacilliform, at first united transversely into a straight tabular series, subsequently forming oblique series; valves with a longitudinal row of puncta, and an excentric keel; marine.

B. paradoxa (Pl. 16. fig. 14, and Pl. 18. fig. 17). Front view of frustules linear, rectangular, valves linear-lanceolate; length 1-220″. (*a*, front view of oblique series of frustules; *b*, valve.)

B. socialis, Greg., and *B. cursoria*, Donk.

BIBL. Kütz. *Sp. Alg.* and *Bacill.*; Smith, *Brit. Diat.* ii. 8; Rabenhorst, *Fl. Alg.* i. 165.

BACIL'LUS, Cohn.—A genus of Schizomycetous Fungi.

Char. Filaments very minute, straight, slender, short or of moderate length, rigid or flexible, moveable or not, joints indistinct; never found naturally in the Zoogloea-form.

B. subtilis (Pl. 7. fig. 18, Pl. 1. fig. 19). Filaments very slender, elongate; joints single or many, with a cilium at each end; movement flexuous, active. In stagnant waters, &c. It forms Pasteur's butyric ferment, and the hay-bacillus; length 1-5000″ and upwards.

B. anthracis. Like the last, but generally longer, motionless; length 1-6000″ and upwards. In the blood and tissues of cattle and sheep, the horse, &c., producing the disease termed *Anthrax*, or splenic malignant fever, the Charbon of the French, the Milzbrand of the Germans, also the human malignant pustule, and the wool-sorters' disease.

B. ulna (Pl. 7. fig. 20). Filaments jointed, thick and rigid, movement rotary and progressive. Warming describes cilia as in

Bacterium termo. In infusions, salt and fresh; in stale infusions of boiled egg; length 1-600″.

B. ruber. Filaments single, or in twos and fours, movement very active. In a red mucilaginous matter on rice.

Other species have been described: *B. malariæ* (ague-fungus), Klebs; *B. viride*, v. Tieghem; *B. leprosus*, in leprosy; and *B. typhi abdominalis.*

Amylobacter is sometimes referred to *Bacillus.*

Reproduction is stated to occur by fission, and by the formation of globular or oval spores developed within the joints; some of these form resting-spores. In *B. anthracis*, cultivated in the dog, sporanges with 3 to 6 spores are stated to be found. Cohn also describes globular or elliptical strongly refractive headlets, supposed to be germinated from gonidia. See SCHIZOMYCETES.

BIBL. That of BACTERIUM.

BACTERIAS'TRUM, Shadb.—A doubtful genus of marine Diatomaceæ, characterized by the compound cylindrical frustules, forming a filament, and the discoidal valves with radiate marginal slender rays.

B. curvatum (Pl. 18. fig. 18). Rays entire, arched; *B. furcatum*, rays straight, forked; *B. nodulosum*, rays simple, straight, covered with nodules; *B. Wallichii*, rays simple, straight.

BIBL. Shadbolt, *Qu. Mic. Jn.* ii. 14; Rabenhorst, *Fl. Alg.* p. 322; Lauder, *Mic. Tr.* 1864, p. 7.

BACTERID'IUM=BACILLUS.

BACTE'RIUM, Ehr.—A genus of Schizomycetous Fungi.

These organisms were formerly arranged with the Infusoria; subsequently with the Algæ, with which Davaine, Rabenhorst, Cohn and Cienkowski still associate them, on account of the resemblance of form, the grouping, the mode of multiplication, and their affinities with the genera *Beggiatoa* and *Leptothrix.*

Char. Cells cylindrical or elliptical, very minute, single or in twos during division, rarely four; motion oscillatory.

Many species have been described. By repeated subdivision *Bacteria* are resolved into a *Micrococcus*-form (Cienkowski).

B. termo (Pl. 7. fig. 17*a*, and Pl. 1. fig. 20). Colourless; twice to five times as long as broad, slightly swollen in the middle, joints one or two; length 1-1900″–1-12000″; breadth 1-12000″–1-50000″. Occurs in animal and vegetable infusions; often becoming surrounded with gelatinous matter forming masses—the Zoogloea-form. Furnished with a cilium at each end (Dallinger and Drysdale, and Warming).

This is the first and true cause of ordinary putrefaction.

B. catenula (fig. 17*b*). In fœtid infusions, and the excretions of typhoid fever.

B. punctum (fig. *c*). In animal infusions; length 1-5000″, breadth 1-10000″.

B. triloculare (fig. 17*d*). Oval, two to five times as long as broad, with from 3 to 6 joints; length 1-2000″–1-5000″.

B. lineola (fig. 17*e*). Cells straight or slightly curved, larger than *B. termo*, single or in twos; movement active. In animal and vegetable infusions, marine and fresh water. Zoogloea-plasma with dark puncta. Turns milk sour.

Some coloured species have been described: *B. xanthium*, in cows' milk, colouring it yellow; *B. syncyanum*, in sour milk, rendering it blue; *B. æruginosum*, in pus, rendering it blue; *B. brunneum*, in brown decomposing infusions of maize; *B. rubescens* and *sulphuratum* appear to be the same as *Monas vinosa.*

Many of the *Bacteria* may be well preserved by simply drying them upon a slide.

Numerous other organisms are sometimes included under the term Bacteria, some of them globular. The subject will be treated generally under SCHIZOMYCETES. See also COCCOBACTERIA and MICROCOCCUS.

BIBL. Ehrenb., *Infus.*; Dujardin, *Inf.*; Sanderson, *12th* and *13th Privy Council Repts.*; Cohn, *Beiträge*, i. and ii.; Pasteur, *Ann. de Chimie*, 1862, 66; Warming, *Vidensk. Medd. Kjöbenhavn*, 1875, 322; Lankester, *Qu. Mic. Jn.* 1873, 408; Magnin, *Bactéries*, 1878; Koch, *Cohn's Beit.* 1877, ii.; Davaine, *Dict. Encycl., Art.* Bactérie; Archer, *Qu. Mic. Jn.* 1878, xviii. 455; Ewart (*B. anthracis*), *Proc. Roy. Soc.* 1878; Dallinger, *Jn. Mic. Soc.* 1878, i. 175 (figs.); Cienkowski, *Mém. Ac. Pétersb.* xxv. (*Qu. Mic. Jn.*), 1878, xviii. 456; Roberts, *Phil. Tr.* 1874, 466; Waldstein, *Qu. Mic. Jn.* 1880, xx. 190; Lister, *Qu. Mic. Jn.* xiii. 380; Livon, *Jn. Mic. Soc.* 1879, ii. 760 (Bacteria no poison); Dowdeswell (*Atmospheric*), *Qu. Mic. Jn.* 1878, xviii. 82; Klebs, *Zeitschrift*, 1879; V. Tieghem, *Bull. Soc. Bot. Fr.* (*Jn. Mic. Soc.* 1880, i. 89); Tyndall, *Putrefaction &c.*, 1881.

BACTRID'IUM, Kunze.—A genus of Torulacei (Coniomycetous Fungi); micro-

scopic plants of tufted habit, growing upon decaying wood, old bark, &c.; white at first, but coloured subsequently by the condensation of the grumous contents of the spores. Three species are recorded as British:

Fig. 51.

Bactridium candidum. Magnified 200 diameters.

B. flavum, Kze. On elm stumps.

B. Helvellæ, B. and Br. On *Peziza testacea*.

B. atrovirens, B. On dead stumps.

Bibl. Berkeley, *Brit. Fl.* ii. pt. 2. p. 350; *Crypt. Bot.* p. 330; Kunze, *Mycol.* Heft i. pl. 1. fig. 2, pl. 2. figs. 20 and 21; Nees, *Nova Acta*, ix. pl. 1. fig. 3, pl. 2. fig. 21.

BADHA'MIA, Berk.—A genus of Myxogastres (Gasteromycetous Fungi), consisting of little variously-coloured sacs growing in patches on decayed oak-branches, &c.; allied to *Physarum*, but remarkable for the spores, at first enclosed in a common sac, adhering in clusters. Filaments of the capillitium broad.

Bibl. Berk. *Linn. Tr.* xxi. 152, pl. 19; *Crypt. Bot.* p. 338.

BÆOMY'CES, Pers.—A genus of Lichenaceous Lichens.

The four species are found on the earth and stones.

Bibl. Leighton, *Lich.-Fl.*, 50.

BAIRDIA, M'Coy.—A marine genus of Bivalved Entomostraca, belonging to the Ostracoda and related to the Cypridæ. First known by its valves alone, which are subtriangular. Abundant, both recent and fossil; found also in the Palæozoic rocks.

Bibl. M'Coy, *Carb. Foss. Ireland* (1844), 165; Jones, *Monog. Tert. Entom.* 51; G. S. Brady, *Linn. Tr.* xxvi. 360 and 388; Jones and Kirkby, *Q. Jn. Geol. S.* xxxv. 565 (5 pls.).

BALANI'NUS, Germ.—A genus of Coleoptera, of the family Curculionidæ.

B. nucum is well known as depositing its eggs in nuts, upon which the larva lives, and from which it escapes, leaving a hole.

The beetle is 1-3″ long, with a rostrum nearly as long as the body. Larva white, with a brown head and strong jaws.

Bibl. Stephens, *Brit. Col.* p. 232; Boisduval, *Ent. Hortic.* p. 152; Calwer, *Käferbuch*, 548 (fig.).

BALANTIDIUM, Cl. & L.—A genus of Infusoria, fam. Bursarina.

Like *Kondylostoma*, but the body dilated behind and narrowed in front.

B. entozoon. In the human intestines, and those of frogs.

Bibl. Cl. & Lachm. *Infus.* p. 227.

BALSAM (Canada). The liquid resin of the *Pinus Balsamea*. This is the ordinarily used and best medium for the preservation of dry transparent objects. The more colourless it is, the better. It should be kept in a wide-mouthed bottle, covered by a large cap, fitted by grinding. A piece of iron-wire should be kept in the bottle, so that the desired quantity can be easily removed. It becomes thicker by keeping, but may be rendered thinner by mixture with oil of turpentine and digestion at a gentle heat, or with benzole. If too thin, it should be exposed to a gentle heat in a bottle covered with paper, to exclude dust. See Preservation.

BALSA'MIA, Vittadini.—A genus of Tuberacei (Ascomycetous Fungi), characterized by the hollows which are lined by the fructifying cells not leading to the surface, and its cylindrical or oblongo-elliptic even sporidia.

Balsamia platyspora occurs in different parts of England, and is eagerly scratched up by squirrels attracted by its strong scent.

Bibl. Tulasne, *Fungi Hypogæi*; Berk. *Outl.* p. 378; Cooke, *Handbook.*

BANA'NA. See Musa.

BANG'IA, Lyngb.—A genus of Porphyreæ (Florideous Algæ), placed among the Ulveæ by most authors, but stated by M. Thuret to be Florideous. Species marine, forming purplish, brownish-green, or red tufts of filaments, upon rocks and stones or on the fronds of other Algæ, from 1 to 4 inches long, or in *B. ciliaris*, only half a line long. Harvey admits five, three of them, however, as doubtful:

B. fusco-purpurea, Dillw. Brownish green or purple glossy, several inches long; near highwater mark. *Phyc. Brit.* t. 96; *Brit. Algæ*, t. 25 C; *Eng. Bot.*, t. 2055 & 2085.

B. ciliaris, Carm. Forming a minute pink fringe on *Zostera marina*.

B. ? *ceramicola*, Lyngbye. Purplish rose. On small Algæ; about 1″ long.

B. ? *carnea*, Dillw. Pale red tufts on Confervæ.

B. ? *elegans*, Chauv. Minute tufts 1‴ or 2‴ long, rose-red, parasitic on small Algæ, rare. Harv. *Phyc. Brit.* t. 246.

See Schizogonium.

Bibl. Harvey, *Mar. Algæ*, 1849, 217 (figs.); Berthold, *Jn. Mic. Soc.* 1881, i. 97.

BAR'BULA, Hedw.—A genus of Pottiaceous Mosses, synonymous with *Tortula*, and including some of our commonest mosses, growing on walls &c.

BIBL. Wilson, *Bryol. Brit.* p. 134.

BARK.—The outer coat of the trunks and branches of Dicotyledonous shrubs and trees, succeeding to the epidermis as the young shoots become solid and woody. Bark is a complicated structure, composed of elementary tissues of various characters; and the great differences of appearance which it presents upon trees which have attained a certain age, result from the growth and multiplication of the elementary organs being subject to very different laws in different plants. Bark is the collective term applied to the entire cortical mass outside the cambium-region of the stem (CAMBIUM). It contains three distinct regions or forms of structure; and in young branches the epidermis, still remaining on the outside, constitutes a fourth.

If we examine a young shoot of the Maple (*Acer campestre*) while still green, by making transverse and perpendicular-radial sections, we find the surface to be covered by an epidermis composed of small cells, closely conjoined at their sides. Under this occur six or eight strata of thin-walled, colourless cells, which stand vertically over one another, and when mature are extended in the radial direction of the branch. These form the *cork-substance, suberous layer*, or *periderm*. Beneath or within these, we find a layer of thin-walled parenchymatous cells, filled with protoplasm and chlorophyll granules, forming the *cellular envelope*, cork-cambium or *phellogen*. Interposed between the cellular envelope and the *cambium* region occur the liber-bundles (see LIBER), forming the *fibrous layer* of the bark. In the bark of the Maple, the corky substance grows very fast at first, and soon splits the epidermis above it, but after a certain number of years its growth slackens, so that it seldom acquires very great thickness, especially as it is very soft and readily rubbed off; the cellular layer does not grow fast, merely keeping pace with the enlargement of the stem which it surrounds. The layers of liber increase year by year so as to form a very distinct fibrous layer.

In the Cork-Oak (*Quercus Suber*), the bark of which, when young, does not differ much from that of the Maple, the cellular layer grows most in the earlier years, and the epidermis is not destroyed until the third, fourth, or fifth; then the cork-substance begins to increase in an important degree by the multiplication of its cells at the inner side, bordering on the cellular envelope. New layers of cork-cells are produced successively, expanding much in the radial direction. They are thin-walled and destitute of contents, of squarish form (Pl. 47. figs. 16 &17), and soon become dry. The outer layers being unable to expand sufficiently to allow the enlargement of the stem, tear irregularly, and give the surface of the stem a rough and cracked aspect. On old stems we observe that the formation of these layers has not been continuous, but in successive groups or sets, which causes the appearance of a darker and more solid structure, composed of tabular cells, at the points where successive sets of layers adjoin, just as is the case at the lines of union of the annual rings of wood in Dicotyledonous stems. But these lines are very irregular. The cellular envelope takes no share in the formation of the cork of this tree.

In the Birch (*Betula alba*), there is a very decided distinction between the layers of the cork-substance, namely between the large thin-walled colourless cells and the denser tabular cells forming the dark streaks in the cork. The epidermis is succeeded here by a *periderm* composed of tabular cells with brown contents, corresponding to the darker parts of common cork; in stems of 20 years' growth, the bark presents as many as fifty lamellæ of this substance, which lamellæ are separated from each other by layers of the lax white cork-cells. The readiness with which the latter structure gives way causes the lamellæ to peel off in thin scales; and these bring away a portion of the white intermediate structure on both faces, and thus acquire their peculiar silvery aspect.

In the Beech (*Fagus sylvatica*), where the bark is smooth, even on old trees, the growth takes place chiefly in the liber-layers, and the cellular envelope and cork-substance merely expand to make room for the enlargement of the stem; the cork-substance is here a *periderm*, i. e. composed of the flat tabular cells, not loose cork tissue. The Holly, Ivy, and other smooth-barked trees are analogous to this.

The scaling off of the bark of the Plane (*Platanus occidentalis*) arises from the formation of layers of tabular peridermal cells between the layers of liber; the bark outside the layers dries and falls away by the

tearing of these peridermal layers. Here, therefore, the periderm is produced from the cellular envelope.

In the Lime (*Tilia*), the Oak (*Q. Robur*), and other trees, a similar production of peridermal layers within the liber takes place; but the layers remain *in situ* for a long time, and fall away irregularly, often persisting for a considerable number of years as rugged, many-layered scales.

In many of the Coniferæ (such as the Scotch Fir and Larch), the peridermal structure is in like manner developed from the cellular envelope; here, however, the cells are not tabular, but parenchymatous, and multiply and enlarge so as to form a thick layer of cork-like tissue, which loses all relation with the medullary rays. The turpentine-canals and liber-fibres, engaged in this corky periderm, become disturbed and displaced by its irregular growth.

In some plants, such as the Vine, the Honeysuckle, &c., the bark is always stringy, which arises from the formation of each annual layer of liber being followed immediately by the drying-up, and soon by the destruction, of the layers of the preceding year, so that no proper periderm of suberous or cellular layers exists here after the first year. The same takes place in the third or fourth year in *Clematis*.

The scales, plates, and rings of bark thrown off, form the *rhitidome* of some authors.

The inner layers of the bark are especially distinguished by the presence of laticiferous canals in those plants in which that tissue exists; these are said by Schacht to be in many cases a modification of the liber-tissue. Further particulars are given on this head under LIBER, where also the intimate structure of the *liber* will be explained. See also LENTICELS and CORK.

BIBL. Henfrey, *Bot.* (Masters); Mohl, *Vermischt. Schrift.* 1845, p. 212; Hanstein, *Bau d. Baumrinde*, Berlin, 1853; Schacht, *Pflanzenzelle*, p. 237; Sanio, *Pringsheim's Jahrb.* ii. 39; Sachs, *Bot.* 107.

BARLEY.—One of the important cereal grains, furnished by the *Hordeum sativum* and its varieties (Monocot. Plants, N. O. Graminaceæ). The starch of the albumen of the seeds has a form somewhat resembling that of wheat, but it may be distinguished under the microscope (Pl. 46. fig. 2); and the small starch-grains are more numerous and smaller than in wheat or rye, and many of them are in active molecular motion when immersed in water. (See STARCH.) Pearl-barley is obtained by a peculiar mode of grinding, by which the outer coat or shell of the grain is removed.

BARTRA'MIA, Hedw.—A genus of Bartramiaceous Mosses, containing several common species. *B. pomiformis*, with its apple-like capsules, is common on dry sandy banks.

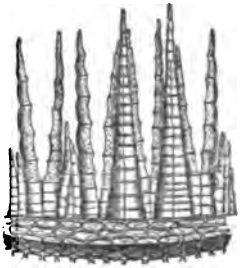
BIBL. Wilson, *Bryol. Brit.* p. 277.

BARTRAMIA'CEÆ.—A tribe of Bartramioideæ (operculate Apocarpous Mosses) containing several genera. British genera:

Conostomum. Calyptra dimidiate. Peristome simple; teeth sixteen, lanceolate, equidistant; *erect when wet or dry*, densely and nodosely tuberculated, with a median line, connate in pairs at their apices, and coherent into an oblique closed cone.

Bartramia. Calyptra dimidiate. Peristome either absent, simple, or double. External, of sixteen lanceolate, smooth, tuberculate teeth, with a median line or sometimes separating in the middle, *erect when wetted, incurved when dry*, red. Internal: a membrane with sixteen folds, produced into sixteen lanceolate, keeled, broad teeth, ultimately split into two divergent articulated lobes, with one to three cilia interposed or none (fig. 52).

Fig. 52.



Bartramia marchica. Magnified fragment of peristome.

Catascopium. Calyptra hood-shaped, smallish. Peristome simple; teeth sixteen, lanceolate, very short, truncate-lanceolate, differing in form, unequal, transversely articulated, with a median line, whitish, rugulose, rigid and suberect. Capsule inclined on the collum, globose, small, discelioid, shining-brown, and ultimately growing black, thick-skinned, almost horny, without an annulus, smooth.

BARTRAMID'ULA, Br. and Sch. (*Bartramia*, Müller).—A genus of Mosses separated from *Bartramia* by some authors on account of the smooth capsule and absence of a peristome.

BIBL. Wilson, *Bryol. Brit.* p. 276.

BARTRAMIOI'DEÆ. — A family of operculated Acrocarpous Mosses, of cæspitose habit and varying size. Leaves very varied

in form, erect or reflexed, with terete nerves; cells parenchymatous, and, except in certain species, furnished with solitary papillæ on the transverse walls on both faces, mostly square or more or less hexagonal; lax or loosish, and densely filled with chlorophyll, or with a persistent primordial utricle, rarely thickened. Capsule with a long neck, funarioid, pear-shaped or spherical, regular or asymmetrical, straight or variously inclined, smooth or grooved, with an operculum mostly hemispherical or conical, rarely beaked. This family is divided into two tribes:

MEESIACEÆ. Areolation of the leaf lax, smooth, often destitute of primordial utricle (*Meesia*), or lax and densely papillose (*Paludella*). Capsule erect, elongated, with a more or less elongated neck, hence *more or less pear-shaped*, smooth, the *neck bearing stomata.*

BARTRAMIACEÆ. Areolation either lax and smooth, lax and papillose, dense and smooth, or dense and papillose. Capsule erect or inclined, horizontal or pendulous, regular or asymmetrical, smooth or grooved, *but more or less spherical, devoid of stomata.*

BARYTA.—A knowledge of the crystalline forms of the salts of baryta is sometimes useful in determining the presence of this substance.

Butyrate of baryta (Pl. 10. fig. 23). When rapidly separating from an aqueous solution, forms a pearly film upon the surface, consisting of dense aggregations of very transparent crystalline laminæ, not perfectly separable from each other (*a*). When more slowly formed, stellate groups of crystals are produced (*b*). The individual crystals are rarely perfect; and some are so thin and transparent that their outlines are scarcely distinguishable.

Hydrofluosilicate of baryta (Pl. 10. fig. 24). Its production is a test for the presence of baryta. The crystals are scarcely affected by either nitric or muriatic acid.

Sulphate of baryta (Pl. 10. fig. 25). When rapidly formed, consists of crystalline granules (*a*). When more slowly precipitated from dilute solutions, it consists of very minute stellate foliaceous crystals, somewhat resembling those of the ammonio-phosphate of magnesia (*b*). See STRONTIA and LIME.

BASALT. See ROCKS.

BASEMENT MEMBRANE, of Animals.—Is a very thin, transparent, elastic and structureless membrane, lying between the cutis and epidermis of the skin, and between the epithelium and submucous tissue of the mucous membranes and their prolongations. It is of considerable firmness, and serves to support the layer or layers of epidermal or epithelial cells. It is not always easily separable and demonstrable, but is perhaps most readily so in the urinary tubules of the kidneys.

In chemical composition, this membrane mostly resembles elastic tissue.

BASID'IA. See BASIDIOSPORES.

BASIDIOMYCETES.—A name applied by Sachs to those Fungi which have naked spores situated in a distinct hymenium. See AGARICINI and FUNGI.

BASID'IOSPORES.—The name applied to the acrogenous spores produced in groups, mostly of a definite number, more frequently of four, on the hymenium of many Fungi, the term *basidium* (sporophore, Berk.) being applied to the four-branched cell upon which they are attached. Basidiospores are produced both by the Hymenomycetous and Gasteromycetous Fungi. In the former they are found upon the external fruit-bearing surfaces, such as the gills or vertical plates of Agarics, on the walls of the tubes of *Polyporus*, &c. In the Gasteromycetes

Fig. 53.

Development of the basidiospores of Hymenangium griseum.

they are produced upon the convoluted hymenium which occupies the interior of the

Fig. 54.

Basidia and basidiospores of Melanogaster variegatus.

Fig. 55.

Basidia and basidiospores of Octaviana asterosperma.

Magnified 400 diameters.

Fungus in the earlier stages of growth; and when the spores are mature, the hymenium

and the basidia becoming dissolved, the spores fall loose in the cavity. The basidiospores sprout out gradually from the basidia, becoming soon shut off by a cross septum; and in some cases they finally acquire a dense and dark-coloured outer coat.

BIBL. Berkeley, *Ann. N. H.* i. 81, pl. 4 and 5, iv. 155, pl. 5; Léveillé, *Ann. Sc. Nat.* 2 sér. viii. 391, pl. 8-11; Tulasne, *Fungi Hypogæi*, passim.

BAST or BASS. See LIBER.

BATARRE'A, Pers.—A singular genus of Trichogastres (Gasteromycetous Fungi), characterized by a universal gelatinous volva, and a hat-shaped receptacle seated on the top of a tall stem.

B. phalloides is occasionally found in England, but only in a very few localities, either in sand or in the dusty residue in the inside of hollow trees.

BIBL. *Soc.* t. 330; Berk. *Out.* p. 290.

BATHYS'IPHON, Sars. — A delicate thread-like spicular Foraminifer.

B. filiformis. In the Bay of Biscay and the Norwegian fjords; length 1" and more.

BIBL. Sars, *Vidensk. Selsk. Forhandl.* 1871, p. 251.

BATONE'US, Kirch.—A doubtful genus of Phytoptidæ; found on the roots of *Populus tremula*. See PHYTOPTIDÆ.

BATRACHOSPER'MEÆ.—A family of Confervoid (?) Algæ. Brownish-green or purplish freshwater plants; filamentous, coated with gelatine. The fronds composed of aggregated longitudinal filaments, bearing at intervals whorls of short, horizontal, cylindrical or beaded, jointed ramuli. Diœcious. Fructification: ovate spores attached to the lateral ramuli, which consist of minute dichotomous filaments. British genera:

Batrachospermum. Lateral whorled ramuli beaded; spores collected in globular knobs in the whorls.

Thorea. Stems continuous, whorled, articulated, sometimes branched, ramuli cylindrical, the spores at their bases.

BIBL. See these genera.

BATRACHOSPER'MUM, Roth.—A genus of Batrachospermeæ (Confervoid Algæ), regarded by Thuret and A. Braun as referable to the Florideæ; consisting of delicate, branched, filamentous plants of green, yellow, red, or purple colour, growing in clear slowly running fresh water. The branched axes of the plants of *Batrachospermum* (fig. 56) consist of rows of large cylindrical cells applied end to end, and increase in length by the successive transverse cell-division of the terminal dome-shaped cell. While the cells or joints of the axes are still young, they send off a number of radiating processes, which soon become cut off by septa, so as to constitute distinct cells, and then elongate and ramify so as to form the whorls of articulated ramules (fig. 59), which at length become very dense (fig. 57). From the basal cells of these branches

Fig. 56.

Fig. 57.

Fig. 59.

Fig. 58.

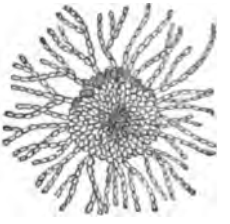


Fig. 56. Batrachospermum moniliforme. Natural size.
Fig. 57. A portion of an axis with whorls of branches. Magnified.
Fig. 58. A tuft of branches with spores in the midst. More magnified.
Fig. 59. Highly magnified view of a few cells of an axis with nascent radiating ramules and their descending cortical cells.

secondary branches grow down perpendicularly over the cell of the main axis immediately below (fig. 59), forming at length a kind of rind over it. This differs from the analogous structure in *Chara*, in the fact that there branches grow up as well as down from each articulation of the axis, and meet halfway. Some of the ramules which grow out free become fertile, and produce spores at their extremities, while others grow out into transparent capillary points.

The spores are produced in large numbers in each tuft, forming an agglomerated heap (fig. 58) at each articulation. The branches of the main axis are produced by lateral budding of its cells, just above and as it were in the axils of the smaller whorled

branches. Braun has found specimens of *B. cærulescens* and *B. Suevorum* destitute of the glomerules of spores, but with smaller hyaline (Antheridial) cells at the ends of the branches, as in NEMALEON.

According to Bornet and Thuret, trichogynes exist. These consist of a basal cell (ultimately the cystocarp), communicating by a narrow neck with the upper portion, which is not capillary, but expands into an oval cell, to which the antheridia adhere. These are single, rounded cells, arising from the summit of certain peripheral elongated branches; each producing a single spermatozoid.

The specimens frequently change colour when dried upon paper, becoming usually much darker. Bory St. Vincent carefully examined the distinctive characters of this genus; and he is followed by Hassall, who, however, erects several of his varieties into species. The following forms are given under Kützing's arrangement: —

B. moniliforme, Roth. Vaguely and greatly branched, colour various (purple, violet, green, æruginous, fuscescent, or nigrescent); whorls or nodes moniliform, distinct, globose, those of the branches confluent. Dillwyn, Tab. ii.; Kütz. *Tab. Phyc.* iii. pl. 22. Hassall's *pulcherrimum*, *stagnale*, and *rubrum* are considered to be varieties of this.

B. giganteum, Desv. Very large, purple when dry, axes clothed with very long, bifurcated branches. Kütz. *Tab. Phyc.* iii. pl. 23. *B. confusum*, Hass.

B. affine, Kütz. *Tab. Phyc.* iii. pl. 24.

B. cærulescens, Bory. Æruginous, slender, very much branched, branches flagelliform, equal, slender, slightly thickened at the tips, whorls of the lower and upper branches confluent, those of the intermediate distinct, contiguous, depressed. Kütz. *Tab. Phyc.* iii. pl. 24.

B. vagum, Ag. Æruginous, dichotomously branched, equally thick throughout, whorls all confluent. Kütz. *Tab. Phyc.* iii. pl. 25; var. *tenuissimum* = *Conf. atra*, *Eng. Bot.* pl. 690.

Rabenhorst admits two species, *B. moniliforme*, with nine, and *B. vagum*, with five varieties.

BIBL. Bory St. Vincent, *Ann. d. Muséum*, xii. pl. 22, 29; Hassall, *Algæ*, p. 101, and pls. 13–16 and 63; Decaisne, *Ann. d. Sc. Nat.* 2 sér. xvii. p. 340, pl. 15, i.; Braun, *Verjüngung*, p. 160 (*Ray Soc.* 1853, p. 150); *Alg. Unicell.* Appendix, p. 105; Kützing, *Sp. Alg.* p. 535, *Tab. Phyc.* iii.; Rabenhorst, *Fl. Alg.* iii. p. 404; Bornet and Thuret, *Ann. d. Sc. N.* 1867, vii. p. 144; Sachs, *Bot.* 1874, 293.

BDELLA, Latr. (*Scirus*).—A genus of Arachnida, of the order Acarina, and family Bdellea.

Char. Those of the family (see Arachnida). Species numerous.

B. longicornis (*vulgaris*) (Pl. 6. fig. 31 *a*, *b*, mandible). Scarlet; rostrum longer than the front segment of the body; eyes 4; length 1-24".

B. cærulipes (Pl. 6. fig. 31 *c*, mandible). Rostrum tolerably short and stout; mandibles thick and obtuse; eyes 4; body reddish; legs blue.

B. elaphus (Pl. 6. fig. 44). Rostrum inflated at base; carmine-red, with iridescent shades; eyes 2, blackish; a long bristle on each side.

Other species.

BIBL. Gervais, Walckenaer's *Apt.* p. 154; Koch, *Deutschl. Crust. &c.*; Dugès, *Ann. d. Sc. Nat.* i. 21; Murray, *Econ. Entom.* 144.

BDELLEA.—A family of Arachnida, of the order Acarina.

The members are minute, more or less soft, variously coloured, and live in damp places beneath moss, upon the sand of caves, &c. Palpi geniculate, attached to the sides of the rostrum, as the antennæ in the Curculionidæ. Movements slow. The single genus,

Bdella, has the characters of the family, and includes the genera *Scirus*, Dug., and *Amonia*, Koch.

BIBL. Gervais, Walckenaer's *Apt.* p. 154; Koch, *Deutschl. Crust. &c.*

BDELLOIDI'NA, Carter. — A sessile, arenaceous, Lituolid Foraminifer, with numerous, transverse, successive, sublabyrinthic chambers.

BIBL. Carter, *Ann. N. H.* March 1877, p. 201.

BEAN-FLOUR.—The flour of the common bean, *Faba vulgaris*, is used to adulterate wheat-flour; and that of the locust-bean, *Ceratonia siliqua*, to adulterate coffee. See ADULTERATION and STARCH.

BEAN'IA, Johnst.—A genus of Infundibulate Polyzoa, of the suborder Cheilostomata, and family Eucratiidæ.

Distinguished by the creeping adherent branched thread, upon which the sessile erect scattered cells are placed, each with two rows of spines on one side.

B. mirabilis. Parasitical on shells and

rocks at or within low water-mark, or creeping among the roots of *Bugula* (*Cellularia*) *avicularia*. Cells 1-24″ long.

Bibl. Johnst. *Br. Zooph.* x. 371; Gosse, *Mar. Zool.* ii. 15; Busk, *Catal.* (Brit. Mus.); Hincks, *Polyz.* 95.

BEE. See Apis.

BEER.—The fermentation by which this liquid is produced results from the growth of the yeast-plant, a microscopic Fungus. See Yeast and Fermentation.

When ammonia is added to beer, a precipitate of the ammonio-phosphate of magnesia falls, resembling that subsiding from urine under the same circumstances (Pl. 13. fig. 3). This, in the sugar-beer as now made, is almost absent; and the beer is deprived of an important element of nutrition.

BEGGIA'TOA, Trevis.—A genus of Oscillatoriaceæ (or properly Schizomycetes), distinguished by the free, rigid, sheathless fibres, enveloped in mucus, and the white granular endochromes. Five species: found in warm mineral and sulphur springs.

Bibl. Rabenhorst, *Fl. Alg.* ii. p. 94.

BELBA, Heyden (*Damæus*, Koch).—A genus of Arachnida, of the order Acarina and family Oribatea.

Char. Cephalothorax ribbed; abdomen separated from the thorax, rounded as if bulbous; legs long, geniculate, with one claw.

The species live on moss, under stones, &c.

B. geniculata. Beneath the bark of the pear-tree, &c.

Bibl. Walcken. *Aptères*, iii. (Gervais), p. 256; Koch, *Uebers. &c.*; Murray, *Econ. Entom.* 215.

BENZOIC ACID.—This acid is well known as occurring naturally in benzoin and some other resins. It is found in animal secretions (urine) as a product of the decomposition of hippuric acid. It is also a product of the oxidation of proteine compounds. It is but slightly soluble in cold, more readily in hot water and in alcohol, also in ether.

Its crystals belong to the right-rhombic prismatic system. It is readily sublimed; and the crystals thus produced form shining delicate needles. When crystallized from a solution, it usually forms dendritically arranged superimposed plates, with angles of 90°, sometimes narrow six-sided needles or prisms; occasionally the angles are truncated, so that the inclination of the edges amounts to an angle of 135°.

It is not unfrequently obtained from urine when not fresh, in attempts to procure hippuric acid. It may be distinguished from hippuric acid by its much greater solubility in ether, by its crystallization in thin plates, and their form (Pl. 11. fig. 13).

BERGMEHL.—The German expression for mountain-flour. A powdery or more or less coherent mineral, consisting principally of the siliceous valves of the Diatomaceæ. In some countries it is mixed with articles of food in times of scarcity. See Diatomaceæ.

BERKELEY'A, Greville.—A genus of Diatomaceæ (Cohort Naviculeæ).

Distinguished by the navicular frustules being immersed in the branches of the gelatinous frond, which is rounded at the base.

The valves are exceedingly thin, brittle and transparent. No markings have been detected upon them; but there can scarcely be a question that they exist.

B. fragilis (Pl. 19. fig. 8). Filiform branches mostly simple, crowded; valves lanceolate, obtuse; length 1-330″. British.

Branches about 1-4″ in length. Found upon marine plants and rocks.

B. adriatica. Branches lax, subdivided, attenuate and flagelliform; valves narrowly lanceolate, almost linear, somewhat obtuse; length 1-200″.

Bibl. Grev. *Crypt. Fl.* tab. 294; Ralfs, *Ann. N. H.* 1845, xvi. p. 110; Kützing, *Bacill.*, and *Sp. Alg.*; Smith, *Br. Diat.* ii. 67.

BET'ULA, L.—The Birch-tree (Dicotyledonous Plants, N. O. Betulaceæ), remarkable for its peculiar silvery periderm. See Bark. The bark of *B. nigra* contains reservoirs filled with an aromatic oil and also a peculiar resin, called Birch Camphor, which is used in the manufacture of Russia leather.

BEYRICH'IA, M'Coy.—An extinct genus, belonging probably to the Ostracoda, very abundant throughout the palæozoic rocks, and presenting a great variety in their small oblong and deeply lobed valves. Forty-two species are recorded from the Silurian, two from the Devonian, and seven from the Carboniferous rocks.

Bibl. Jones, *Ann. N. H.* 1855, xvi. 81 & 163; *Mn. Mic. Jn.* 1870, 191.

BIBLA'RIUM, Ehr.—A genus of fossil Diatomaceæ.

Distinguished from *Tetracyclus* by the frustules being single, which difference probably depends upon the species only having been found by Ehrenberg in the fossil state.

Twelve species (Pls. 50. fig. 39; 18. figs. 38–48). Fossil in Siberia and Oregon.

Bibl. Ehrenberg, *Ber. d. Berl. Ak.* 1844–45, and *Ann. N. H.* 1848, i. 393; Kützing, *Sp. Alg.*; Smith, *Br. Diat.* ii. 37.

BICELLA'RIA, De Bl.—A genus of Infundibulate Polyzoa, of the suborder Cheilostomata, and family Bicellariidæ.

B. ciliata (*Cellularia ciliata*, Johnst.) (Pl. 41. figs. 5 *a* and 5 *b*), is parasitical upon Algæ, Polypi, &c. within low-water mark; spines about eleven.

An elegant microscopic object.

B. Alderi; spines six.

Bibl. See Bicellariidæ.

BICELLARIIDÆ (*Cellularia*, Johnst. in part).—A family of Infundibulate Polyzoa, of the suborder Cheilostomata.

Distinguished by the erect plant-like polypidom being dichotomously divided into narrow ligulate branches in two or more rows; the absence of whips (vibracula); and the avicularia when present being stalked and jointed. Genera (British):

Bicellaria. Cells top-shaped, distinct, armed with spines; orifice looking upward.

Bugula. Cells elliptical, closely contiguous; orifice very large; margin simple, not thickened (avicularia frequently red or blue).

Bibl. Johnston, *Brit. Zooph.*; Busk, *Cat.* (Brit. Mus.); Hincks, *Polyz.* 67.

BICHRO'MATE OF POTASH. See Potash.

BICOSŒ'CA, Clark.—A genus of Flagellate Infusoria.

Char. Solitary, two flagella, 1 long and 1 short; contained in a stalked horny lorica.

B. lacustris (Pl. 53. fig. 10). Pond-water, common.

B. gracilipes. Stalk long; marine.

Bibl. Kent, *Inf.* p. 274.

BIDDULPHIA, Gray.—A genus of Diatomaceæ.

Char. Frustules compressed, quadrilateral, connected with each other by the angles; filaments attached by a stipes; angles of the frustules equal and produced; valves covered with depressions (visible by direct light), giving them a cellular appearance; centre of valves with spines; marine.

This genus resembles *Isthmia* and *Amphitetras* in the general appearance of the frustules and valves. But it differs from the former in the angles being alike, and from the latter in the compressed side view of the frustules. Frustules often with rounded transverse elevations, between which are costæ or shallow vittæ. Those in which the angles are more prolonged and acute, and the markings indistinct, are retained by Kützing in the genus *Odontella*, Ag. (*Denticella*, Ehr. in part).

B. pulchella, Ehr. (*B. tri-, quinque-*, and *septemlocularis*, Kütz.) (Pl. 16. fig. 15). Costæ 3–7, central one with two or three short spines; produced angles rounded; markings coarse; length 1-400 to 1-200″.

B. aurita, Bréb. (Pl. 19. fig. 9). Markings indistinct; costæ none; angles horn-like; spines two or three, central; length 1-800″.

B. rhombus, Smith (*Zygoceras rh.* Ehr.?) (Pl. 19. fig. 13, Ehr.; Pl. 50. fig. 16, Smith). Markings indistinct; costæ none; spines near the hoop; angles horn-like; length 1-60 to 1-260″.

B. Baileyi, Sm. Markings indistinct; costæ none; angles horn-like; sides of frustules with two slight elevations, each with one or two long spines; length 1-250″.

B. turgida (*Cerataulus turgidus*, Ehr.). Markings faint; costæ none; angles cylindrical, truncate; frustules with a row of short and two large submedian spines on each side; length 1-240″.

B. Regina. Sides of frustules each with three rounded median elevations; spines none; angles rounded, with distinct markings; length 1-220″.

Several other species, but not British.

Bibl. Kützing, *Bacill.* and *Sp. Alg.*; Ehrenb. *Ber. de Berl. Ak.* 1843 & 1844; Ralfs, *Ann. N. H.* 1843, xii. 273; Smith, *Br. Diat.* ii. 47; Greville, *Micr. Tr.* 1864, pp. 9, 85; 1865, pp. 6, 19, 49; 1866, pp. 6, 81; Rabenhorst, *Fl. Alg.* i. p. 310; Pritchard, *Infus.* p. 847.

BIFORI'NES.—Under this name Turpin described certain cells occurring in the septa of the air-chambers of the leaves of the Araceæ, characterized especially by the presence of a large bundle of raphides. They contain a thick fluid; and when they are placed in water, endosmose causes them to burst and discharge the crystals. See Raphides.

Bibl. Turpin, *Ann. Sc. Nat.* 2 sér. vi. p. 5, pl. 1–5.

BIGENERI'NA, D'Orb.—One of the numerous modifications of the Textularian type: instead of continuing to form bilateral alternate (Enallostegian) chambers, it advances in growth with a straight single (Stichostegian) series; and the aperture becomes central, terminal, and rounded, instead of being a transverse arch low down on the septal face. If the aperture be excentric, we have the *Gemmulina* of D'Or-

bigny. *B. agglutinans* (Pl. 23. fig. 50) is an elongate and coarse-shelled variety of *B. nodosaria*. Common in many seas, and in the fossil state.

Bibl. D'Orbigny, *For. Foss. Vien.* 237; Carpenter. *Introd. For.* 191.

BIGNONIACEÆ (Dicotyledons).—The wings of the seeds of this family afford very beautiful objects. They are either thin membranes composed of a layer of lignified cells; or, as in the Catalpas, the wing consists of a fringe of hairs.

BILE.—Three colouring-matters have been obtained from the bile, viz. cholepyrrhine, biliverdine, and bilifulvine. These were formerly regarded as distinct; but later researches have tended to show that they are modifications of the same pigment.

Cholepyrrhine or *bilirubine*, the colouring-matter in its ordinary state, is characterized by the series of tints through which it passes when treated with nitric acid, especially if this contain nitrous acid; becoming first brownish, then green, bluish, violet, red, and finally yellow. It is sometimes found in bile and the liver-cells in the form of yellow semicrystalline grains; also it enters into the composition of biliary calculi.

Biliverdine is found in the bile, but not in gall-stones; it is formed from bilirubine by oxidation. It is most abundant in the bile of the Herbivora.

Biliprasine is brown, becoming green with acids; it occurs in decomposing bile.

Bilifulvine is also sometimes found in bile which has been retained in the gall-bladder. The bile then appears thick and dark brown, and exhibits small dark grains; the crystals are found in these grains. They form longish, very fine needles, of a reddish-yellow colour, either single or several combined. When aggregated, they sometimes resemble the crystals of urate of soda, and are often curved and twisted. Caustic potash dissolves them tolerably readily. Acetic acid produces no change in them. Nitric acid has but little effect upon them, unless the action is very intense, when they are decomposed. Virchow notices the occurrence of these crystals upon the walls of the cysts of *Echinococci* in the liver, where we have also found them, and in the liquid contents of the cysts. In this instance, two kinds of crystals were met with (Pl. 13. fig. 15): some of these were rhombs (*b*), others were twisted and elegantly curved bundles of needles (*a*). When first examined, they were yellowish-red; but after remaining a day or two in the liquid of the cysts, they became almost perfectly yellow. When mounted in balsam, the rhombs remained unaltered, whilst the long filamentous groups of needles lost all colour, leaving a barely distinguishable transparent skeleton. Both kinds were insoluble in acetic acid, but soluble in potash with a yellow colour.

In morbid bile, crystals of cholesterine, globules of fat, and small bundles of needles of margarine are also occasionally found.

See Hæmatoidine.

Bibl. *Gmelin's Handb. d. Chem.* vii. & viii.; Virchow, *An. d. Pharm.* 1851 (*Chem. Gaz.* x.); Karsten, *De hep. et bile Crustac. et Mollusc.*; Frey, *Histol.* &c. 1876, p. 551; Städeler, *Pogg. Annal.* cxxxii. p. 323.

BILHARZIA. See Distoma.

BILIFULVINE. See Bile.

BILOCULI'NA, D'Orb.—One of the Milioline Foraminifera, in which each successive segment embraces more or less completely the preceding segments, on alternate sides, so that only two chambers of the shell are visible externally. It varies much in form and size; the varieties are very common, recent and fossil, and have numerous names: the largest has been found at 650 fathoms in the North Atlantic (*Carpenter*). *B. ringens* (Pl. 23. fig. 3) is taken as the type.

Bibl. D'Orbigny, *For. Foss. Vien.* 261; Williamson, *Brit. For.* 78; Carpenter, *Intr. For.* 75, 78.

BIME'RIA, T. S. Wright.—A genus of Hydroid Zoophytes, family Atractylidæ.

The body and lower part of the tentacles enveloped by an opaque brown membrane.

B. vestita. Attached to zoophytes and sea-weeds.

Bibl. Hincks, *Hydroid Zoophytes*, p. 103.

BINOCULAR MICROSCOPE.—This has been alluded to at p. xiv of the Introduction. We have no space for the figures requisite to illustrate descriptions of the three principal forms of binocular microscope; hence we must be satisfied with referring to the works in which they will be found. In the examination of new structures, no reliance should be placed upon the appearances presented by objects under binocular vision, unless controlled by the means pointed out in the second part of the Introduction.

The three principal forms of binocular construction are those of Wenham, Holmes, and Stephenson.

Tolles has invented a binocular eye-piece (Beale, *How &c.*, p. 15, fig.); and Abbe another: *Jn. Mic. Soc.* 1881, i. p. 298 (fig.).

BIBL. Wenham, *Micr. Tr.* 1860, p. 154, 1861, p. 15, 1866, p. 103; *Qu. Mic. Jn.* 1861, p. 109; Holmes, *M. M. Jn.* 1869, iii. p. 274; Stephenson, *M. M. Jn.* 1870, iv. p. 61; Frey, *D. Mikr.* 1881; Carpenter, *The Microsc.* 1881.

BI'OLITE. See ROCKS.

BIOMYX'A, Leid.—A genus of Rhizopoda.

B. vagans. Resembles the pseudopodia of a *Gromia*, separated from the body. Fr. water.

BIBL. Leidy, *Proc. Phil. Acad.* 1875, (*M. M. Jn.* xiv. p. 88).

BIS'PORA, Corda.—A genus of Torulacei (Coniomycetous Fungi), characterized by its uniseptate spores forming simple and solitary bead-like chains at the apices of short, slender, erect filaments, destitute of septa, arising from a creeping mycelium. It was separated from *Torula* by Corda on account of the double character of the spores. According to Fresenius, the chains of spores are pedicellate as above described, and the growth of the chains appears to take place by division of the terminal cell or spore.

Fig. 60.

Bispora monilioides. Magnified 200 diam.

B. monilioides, Corda, of which fig. 60 represents the chains of spores without the pedicels, is British (*Torula* auct.). On sticks.

BIBL. Corda, *Ic. Fung.* vol. i. pl. 2. fig. 143; Fresenius, *Beitr. z. Mycologie*, Heft 2. p. 27, pl. 6. figs. 46–54; Greville, t. 255.

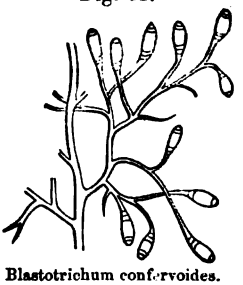
BITARTRATE OF POTASH. See POTASH.

BLASIA, Micheli.—A genus of Pellieæ (Hepaticæ). The British species, *B. pusilla*, L., occurs on moist heaths, not uncommonly in the mountainous parts of England, Scotland, and Ireland. In addition to the antheridia and pistillidia, and the sporanges developed from the latter, this plant produces *gemmæ* of two kinds. One kind is formed in receptacles hollowed out of the nerve, furnished with a long tubular beak, whence the gemmæ escape when mature. The second kind is described as black spherical masses of granular or pulpy substance, and occur within the epidermis on the under side of the frond, often covered by the scales.

BIBL. Hooker, *Brit. Jungermanniæ*, t. 82–84; *Eng. Bot.* t. 1328; *Brit. Fl.* ii. part 1. 130; Sachs, *Bot.* p. 347.

BLASTOTRICHUM, Corda.—A supposed genus of Dematiei (Hyphomycetous Fungi), of curious habit, growing in and out of water upon aquatic plants. *B. confervoides*, Corda (fig. 61), forms felted tufts of an agreeable rose-colour upon living and dead parts of aquatic *Euphorbiæ*, in autumn. The filaments are very much branched, the branchlets dichotomous and subulate; the spores rose-coloured, containing a gelatinous nucleus within. The spores are irregularly divided; and some remain imperfect; but both these and the perfectly septate reproduce the plant when sown. The form occurring above the surface of the water is of closer habit than the submerged, in which the filaments are longer and more lax.

Fig. 61.



Blastotrichum confervoides. Fragment of fertile filament. Magnified 200 diameters.

Berkeley is of opinion that this plant is only a state of some *Dactylium*, perhaps *D.* (TRICHOTHECIUM) *roseum*.

BIBL. Corda, *Icones Fung.* ii. p. 10, pl. 9. fig. 50; Berkeley, *Crypt. Bot.* p. 302.

BLAT'TA.—A genus of Orthopterous Insects, of the family Blattidæ.

Blatta orienta'lis is the common house blackbeetle or cockroach. The head and the various organs of the mouth are figured in Pl. 33. fig. 1, the upper and front view; fig. 2 the under view; fig. 22 the parts of the mouth separate.

Head oval, and concealed beneath the large plate of the prothorax. *Antennæ* (fig. 1 *a*, broken off) very long, setaceous, pubescent, and with very numerous joints; they are inserted close to the inner margins of the eyes; basal joint stout and subovate, second and third squarish, larger than any of the following, which are ring-shaped towards the base of the antennæ, become square (in the side view) at the middle, and oblong at the apex. *Labrum* (fig. 1 *e*, fig. 22 lower part of *a*) exserted, entire, roundish, truncated at the base. *Mandibles* (fig. 22 *b*) short, stout, toothed at the tip and on the inner margin; basal portion of the inner

margin membranous, forming a little lobe. *Maxillæ* (figs. 1 & 2 *g*, 22 *c*) bilobed; inner lobe (lacinia, fig. 22 *c*†) dilated and ciliated on the inner margin, acute, curved inwards at the apex so as to form a tooth; outer lobe (galea, fig. 22 *c* *) longer, thick, rounded and naked; maxillary palpi (figs. 1 & 2 *h*) elongated, rough with short hairs, 4-jointed, the last joint somewhat hatchet-shaped. *Labium* (fig. 22 *e*) elongated, bifid, with two more slender inner lobes; labial palpi (fig. 2 *k*) pubescent, 3-jointed, last joint truncated obliquely. *Mentum* (fig. 2 *l*) short, convex at the base. Eyes (fig. 1 *c*) kidney-shaped.

Thorax semicircular, the base convex; elytra coriaceous, one overlapping the other, and with numerous nerves. Wings large, folded longitudinally, with numerous nerves. Females apterous. Abdomen flat, oval, and terminated by two short, conical, compressed, jointed appendages in both sexes; besides which, in the male, there are two slender, external, not-jointed appendages or styles, also an elongated intermediate one. Legs long and compressed; coxæ elongated and stout; femora stout with a series of spines beneath; tibiæ clothed with very strong movable spines; tarsi 5-jointed, three basal joints gradually diminishing in length; claws curved and acute.

An *Amœba* and some Bursarina are parasitic in the intestines of *Blatta*.

See INSECTS.

BIBL. Westwood, *Introd. &c.*; Kirby, *Brit. Entom.* i. 12.

BLECH'NEÆ.—A family of Polypodiaceous Ferns.

Char. Sori linear or oblong, dorsal, parallel with the midrib and edge of the segments, not close to the latter. Involucre of the same shape as the sorus, superior, opening towards the midrib. Gen.:

Blechnum. Sori linear, continuous or nearly so, parallel with and contiguous to the midrib.

Sadleria. Sori in a continuous line close to the midrib on both sides, placed on an elevated receptacle. Indusium narrow, subcoriaceous, at first wrapped over the sorus, then spreading.

Woodwardia. Sori sunk in cavities in the frond, in single rows parallel with and contiguous to the midribs of the pinnæ and pinnules. Indusium subcoriaceous, closing over the cavity like a lid.

Doodia. Sori oblong or slightly curved, in one or more rows parallel with and between the midribs and the margins of the pinnæ. Indusium membranous.

BLECH'NUM, Linn.—A genus of Ferns. *Bl. Spicant*, With., is the Hard Fern, also called sometimes *Bl. boreale*, but properly LOMARIA *Spicant*.

The species are tolerably numerous, closely resembling each other, and diffused widely throughout Tropical and South Temperate regions.

BIBL. Hooker & Baker, *Syn. Fil.* 183.

BLEPHARIS'MA, Perty, = PLAGIOTOMA, pt.

BLIGHT.—This word is used in common language in an exceedingly loose and undefined way, being applied to almost every cause of disease in plants, as well as to the diseases themselves, which are variously explained by agencies of meteorological conditions, parasitic plants and insects, operating singly or in combination. Blight is, indeed, 'in the air' in many cases, since a frequent source of disease in vegetation is sudden change of temperature or hygroscopic condition of the atmosphere, deranging the processes of evaporation and respiration in the tender, actively developing portions of the foliage or inflorescence of plants. It is also often 'in the air' in another sense, but much less specially than is commonly supposed: the plagues of parasitic fungi and insects which sometimes cause such devastation, seem undoubtedly to arise immediately from the transport of the microscopic reproductive bodies, spores and the like, through the air; but the peculiar atmospheric condition often observed as accompanying the sudden irruption of large masses of such 'blights,' are only collaterally connected with the development of these bodies; the warm overcast weather, almost proverbially designated as the cause or the herald of blights, is merely an index of a condition of the atmosphere especially favourable to the rapid multiplication of the Fungi and Insecta which are seen to increase so rapidly at such times; and the germs of these must be already present, through other causes, for the production of the phenomena under such circumstances.

Only a few of the animal blights need be referred to here, such as the plant-lice, the most familiar form of 'blight' in cultivated plants (see APHIDÆ); the 'pepper-corn' or 'ear-cockle' of wheat, *Anguillula tritici* (see ANGUILLULA); the wheat-midge (CECIDOMYIA); the vine-pest (PHYLLOXERA); the turnip-fly (HALTICA); the PHYTOPTIDÆ;

and the species of *Cynips* and allied genera, which produce galls and similar excrescences by the irritation of the vegetable tissue, resulting from their presence.

Many caterpillars of moths and butterflies are exceedingly destructive, and form a kind of blight; but these scarcely come within our province.

The vegetable blights, the parasitic Fungi growing upon living specimens of the higher plants, and displaying themselves either as the cause or the accompaniment of some disease and disorganization, have of late years become objects of most earnest attention, on account both of the enormous damage which the diseases have caused to crops of plants of high importance to man, and also of the many curious facts in their history which have been brought to light. The Potato blight and the Vine disease of recent years have incited renewed efforts to elucidate the history of these productions, as yet, however, imperfectly made out. The old notion, that these products were the result of skin-diseases or exanthemata of plants, is now discarded, especially as many of them have been grown artificially from their spores.

The general history of the conditions of their occurrence, and a summary of the investigations into their history, are given under the head of PARASITIC FUNGI. The particular history of the more remarkable genera will be found under the heads indicated by the capitals in the following paragraphs.

Corn-blights consist chiefly of *mildew* (PUCCINIA), *rust* or *red-robin* (UREDO, TRICHOBASIS), *smut*, *bunt*, or *brand* (TILLETIA, USTILAGO, POLYCYSTIS), *ergot* (CORDICEPS), &c. CYSTOPUS (*Uredo*) attacks Cruciferous plants. *Mildews* of pease, peaches, hops, and many other cultivated plants are produced by species of ERYSIPHE. OIDIUM is a common mildew, and is known in many cases to be only an earlier condition of *Erysiphe*. BOTRYTIS is another common mildew. ÆCIDIUM forms a kind of *rust*, as is the case with the allied RŒSTELIA, infecting pear-trees. See also UROMYCES, POLYCYSTIS, COLEOSPORIUM, PROTOMYCES, EPITEA, PHRAGMIDIUM, FUSISPORIUM, TORULA, PERIDERMIUM, SCLEROTIUM, SPILOCÆA, SPHÆRIA.

BIBL. De Bary, *Brandpilze*, Berlin, 1853, chap. 3. p. 102; Berkeley, *Tr. Hort. Soc.*, *Gardener's Chron.*, passim; A. Braun, *Krankheiten der Pflanzen*, Berlin, 1854 (*Qu. Mic. Jn.*, July 1854); Sidney, *Blights of the Wheat*, Rel. Tract Soc.; art. *Blight*, in *Brande's Dict.*, *the Penny Cyclop.*; *Libr. of Entertaining Knowledge*; Boisduval, *Entom. Horticole*; Hallier, *Phytopathologie*.

BLINDIA, Br. and Sch.—A genus of Dicranaceous Mosses, including some *Weissiæ* and *Gymnostoma* of authors.

BIBL. Wilson, *Bryol. Brit.* p. 57.

BLOOD.—This animal fluid, with the general appearance of which in the higher animals every one is so familiar, is no less difficult in its microscopic study, than it is complex in its chemical composition. In man and mammalia, birds, reptiles and fishes, it is a viscid liquid of a red colour. In those of the lower classes in which it exists, it is mostly colourless, sometimes, however, red, bluish, purplish, greenish or milky.

When examined under the microscope the blood is found to consist of a liquid portion, containing in suspension a large number of minute corpuscles, which are known commonly as the globules or corpuscles of the blood.

In the Mammalia, Birds, Reptiles, Amphibia, and Fishes generally, the liquid portion, or *liquor sanguinis*, is nearly colourless, or of a pale yellow tinge; and the corpuscles are of two kinds, one of a red colour when viewed in mass, but pale reddish yellow when seen singly or separately, and to these the red colour of the blood is owing; the others consist of perfectly colourless bodies.

The *red corpuscles* are far more numerous than the colourless ones, about 500 to 1, and consist of delicate membranous colourless cells enclosing a red liquid. In the Mammalia they assume the form of circular flattened disks or discoidal cells, the sides of which are impressed or hollowed out, so as to make them resemble doubly concave lenses, with rounded margins (Pl. 49. figs. 21, 22 & 23); in the Camel tribe, however, they are elliptical and doubly convex. In Birds (figs. 24 & 25), Fishes (figs. 26 & 27), Amphibia and Reptiles (figs. 28, 29 & 30), they are elliptical and flattened, the form of the sides varying: thus, in Birds and Fishes they are convex, excepting the Cyclostomes or lamprey Order among the latter, in which they are circular, flattened and slightly concave, only differing from those of man in being somewhat larger; and in the Leptocardea—*Amphioxus lanceolatus*, the lancelet, there are no blood-corpuscles.

In the Amphibia and Reptiles, in which they are elliptical, very large, and comparatively

thin, the surfaces of the corpuscles are rather concave than convex, the nucleus projecting somewhat laterally.

The red corpuscles of the Mammalia are not furnished with a nucleus, whilst in Birds, Fishes, and Reptiles a distinct nucleus exists; this is usually oval, but sometimes rounded in the latter.

The *colourless corpuscles* of the Vertebrata (figs. 21–30 *b*), or the lymph-corpuscles, or the blood-leucocytes as they are sometimes called, are spherical, of a granular appearance, highly refractive, and specifically lighter than the coloured corpuscles. They consist of a cell-wall containing numerous larger or smaller granules and molecules, with one or more nuclei. Acetic acid dissolves the granules, and brings the nuclei to view. The cell-wall is often undistinguishable, unless water be added to the corpuscles, which being imbibed, separates it from the contents. When blood is kept at a moderate heat, these corpuscles exhibit various *Amœba*-like processes, crawl over the slide, and even take up particles of foreign substances, as vermilion, carmine, &c.

The blood of the Invertebrata has not been so thoroughly examined. In many of them there are two circulating liquids—one coloured, and sometimes containing hæmatine, but no corpuscles; the other colourless, and containing rounded or irregular granular colourless nucleated corpuscles (figs. 31–35), much resembling the colourless corpuscles of the Vertebrata, but remarkably prone to shoot out processes like the Amœbæ.

The sizes of the *coloured* corpuscles of many vertebrate animals are given in the subjoined list, nearly all the measurements being those of Gulliver. It may be remarked that, whilst the largest coloured corpuscles occur in the Reptiles, the smallest are found in the Mammalia, and that the size of the corpuscles is in general proportional to the size of the animal, in animals of the same order, but not in those of different orders. Thus, in the larger Ruminants and Rodents the corpuscles are larger than in the smaller ones, whilst the smallest British mammal, the Harvest-mouse, has corpuscles as large as those of the Horse; and in the common mouse they are larger than in the Horse or Ox.

MAMMALIA.

Bimana. Man, 1-3200 to 1-3500″.

Quadrumana. Chimpanzee (*Simia Troglodytes*), 1-3412; Monkey (*Cercopithecus mona*), 1-3468; Monkey, mean of eight other species, 1-3450; Lemur, mean of four species, 1-4077.

Cheiroptera. Bat (*Vespertilio murinus*), 1-4175; Bat (*Vespertilio pipistrellus*), 1-4324.

Insectivora. Hedgehog (*Erinaceus europæus*), 1-4085; Mole (*Talpa europæa*), 1-4747.

Carnivora. Badger (*Meles vulgaris*), 1-3940; Bear, mean of five species, 1-3708; Dog (*Canis familiaris*), 1-3542; Fox (*Canis Vulpes*), 1-4117; Lion (*Felis Leo*), 1-4322; Seal (*Phoca vitulina*), 1-3281.

Cetacea. Dolphin (*Delphinus Phocæna*), 1-3829; Whale (*Balæna Mysticetus*), 1-4000; Whale (*Balæna Boops*), 1-3099; Manatee (*Manatus*), 1-2400.

Pachydermata. Elephant (*Elephas indicus*), 1-2745; Horse (*Equus caballus*), 1-4706; Pig (*Sus Scrofa*), 1-4230; *Rhinoceros indicus*, 1-3765.

Ruminantia. Camel (*Camelus bactrianus*), length 1-3123; breadth 1-5876; Dromedary (*Camelus dromedarius*), l. 1-3254, b. 1-5921; Goat (*Capra hircus*), 1-6366; Musk (*Moschus javanicus*), 1-12325; Stag (*Cervus elaphus*), 1-4324; Ox (*Bos Taurus*), 1-4267; Sheep (*Ovis Aries*), 1-5300.

Edentata. Armadillo (*Dasypus sex-cinctus*), 1-3457; Sloth (Unau, *Bradypus didactylus*), 1-2865.

Rodentia. Guineapig (*Cavia cobaya*), 1-3538; Mouse (*Mus musculus*), 1-3814; Rabbit (*Lepus cuniculus*), 1-3607; Rat (*Mus Rattus*), 1-3754.

Marsupialia. Kangaroo (*Macropus*), mean of three species, 1-3460.

Monotremata. Platypus, duck-billed (*Ornithorhynchus paradoxus*), 1-3000.

Birds. Chaffinch (*Fringilla cœlebs*), length 1-2253, breadth 1-4133; Cuckoo (*Cuculus canorus*), l. 1-2028, b. 1-3600; Eagle (*Aquila*), mean of four species, l. 1-1640, b. 1-3651; Fowl (*Gallus domesticus*), l. 1-2102, b. 1-3466; Gull (Mew-, *Larus canus*), l. 1-1973, b. 1-3839; Humming-bird (*Trochilus*), l. 1-2666; b. 1-4000; Ostrich (*Struthio camelus*), l. 1-1649, b. 1-3000; Owl (*Strix flammea*), l. 1-1882, b. 1-3740; Parrot (*Psittacus*), mean of twelve species, l. 1-2042, b. 1-3724; Pigeon (*Columba*), mean of sixteen species, l. 1-2135, b. 1-3679; Sparrow (*Fringilla domestica*), l. 1-2140, b. 1-3500.

Amphibia and Reptiles. Crocodile (*Crocodilus acutus*), l. 1-1231, b. 1-2286; Frog (*Rana temporaria*), l. 1-1108, b. 1-1821; Lizard (*Lacerta vivipara*), l. 1-1660; *Siren lacertina*, l. 1-435, b. 1-800; Toad (*Bufo vulgaris*), l. 1-1043, b. 1-2000; Triton (*Lis-*

sotriton punctatus), l. 1-830; *Amphiuma*, l. 1-340.

Fishes. Carp (*Cyprinus carpio*), l. 1-2142, b. 1-3429; Eel (*Anguilla vulgaris*), l. 1-1745, b. 1-2842; Jack (*Esox lucius*), l. 1-2000, b. 1-3555; Miller's Thumb (*Cottus gobio*), l. 1-2000, b. 1-2900; Perch (*Perca fluviatilis*), l. 1-2099, b. 1-2824; Tench (*Cyprinus Tinca*), l. 1-2286, b. 1-2722.

The colourless corpuscles do not vary so much in size in different animals as is the case with the coloured corpuscles. Those of the human blood are about 1-2500″ in diameter.

A third corpuscular element of the blood, related to its formation, is described by Norris.

The red corpuscles of blood consist chemically of Hæmoglobine (Hæmatoglobuline); and this is composed of a colouring matter—hæmatine, and an albuminous substance—globuline. They are readily altered in form by most liquids; those of less specific gravity than the liquor sanguinis distend them, rendering them larger, paler, and more transparent, and effacing the lenticular appearance and the elliptical form when present. If a small quantity of water be added, the corpuscles in motion are seen to be highly elastic, becoming altered in shape when coming into contact with each other, but resuming their form when free. If the liquid be added in large proportion, the envelope or cell-membrane becomes extremely thin and pale, until at last it is no longer distinguishable; sometimes it bursts. These phenomena are the result of endosmosis. The red corpuscles, however, are not all equally acted upon: some are much more affected than others; some even appear almost entirely to resist the action of endosmotic agents, and are found but little altered, even when the blood is mixed with a large proportion of water. Although water and other endosmotic agents distend the coloured corpuscles, and render their envelopes so extremely transparent that they can no longer be recognized, yet many of them may be restored to view by the addition of reagents which either act exosmotically, colour them, or render them opaque—as solution of iodine, of bichloride of mercury, and various other salts. Dilute acids act nearly in the same manner as water, but much more rapidly. Dilute solutions of alkalies produce the same effect, but soon dissolve them completely. Solutions of neutral salts act exosmotically, rendering them smaller, more flattened, and producing wrinkles, folds, or a granular appearance in the enveloping membrane. Frequently also they appear covered with little points, giving them an elegant stellate aspect; this stellate or crenate appearance is not unfrequently seen immediately that fresh blood is examined under the microscope, especially at the margins of the drop. Two principal conditions are especially favourable to its production, viz. a concentrated state of the liquid, and an increase in the proportion of alkaline chlorides; the action of alcohol also tends to produce this condition.

The comparative size of the corpuscles in the races of man is treated of by Richardson (*M. M. Jn.* 1877, xvii. 212).

The corpuscles of the blood of the hepatic vein are smaller, more spherical, without the central depression, and resist the action of water for a longer time than the ordinary corpuscles; similar corpuscles are also met with in the spleen. These are by some regarded as young newly formed corpuscles; while those of the portal vein possess the ordinary characters.

Matters which coagulate the albuminous matter of the red corpuscles, such as alcohol, tannic acid, and creosote, also heat, alter their form, giving rise to the production of tail-like processes, with adherent minute globules, which also cover the surface of the corpuscles. And by pressure the latter are broken up into a number of similar globules.

It is a disputed point whether the red corpuscles have a cell-wall or not. The action of osmotic reagents tends to show that they have; and "the membrane can be distinctly seen with 1000 diameters in the newt's corpuscle after the addition of magenta and tannic acid" (Rutherford). Beale shows that they may be crushed into fragments by pressure on the cover; but as the hæmoglobine surely coagulates, this is accounted for; and moreover, the hæmoglobine is readily soluble in water and in serum; and it seems difficult to understand how it resists the solvent action of the serum unless defended by a cell-wall.

The red corpuscles of the blood contain or consist of Hæmoglobine (Hæmatoglobuline). This may be obtained in a crystalline state by adding ether by drops to defibrinated blood, and shaking until the bright and opaque colour of the blood is replaced by that of a syrupy transparence.

After setting aside for some hours, it separates in fine red crystals. Or, on a smaller scale, place a drop of blood on a slide, and add twice as much water, mix the two, and set aside for evaporation. The crystals will then form, often most distinctly at the margins.

Under very high powers, a number of very delicate, colourless, radiating or reticular filaments may be seen traversing the corpuscles, sometimes also the nucleus; probably arising from the coagulation of the contents.

Carbonic acid causes a cloudiness with enlargement in the red corpuscles, removed by oxygen or air, which also contracts them.

Electricity produces smaller or larger processes, the corpuscles finally becoming globular and colourless.

The colourless corpuscles are much less affected by reagents. Water distends them slightly, rendering their granulations less distinct. Acetic acid does the same to a greater extent, bringing to light the nuclei. Alkalies dissolve them. When blood is mixed with a large quantity of water, the mixture shaken and set aside, a pale buff precipitate subsides; this consists of some of the albumen thrown down from the serum, with shreds and walls of ruptured coloured corpuscles, a few of the latter unaltered, and some unaltered or but slightly changed colourless corpuscles.

Almost immediately after the blood of the Vertebrata has left the blood-vessels, it begins to coagulate. Within about three minutes, the surface of the coagulating blood becomes gelatinous; in about ten minutes it is gelatinous throughout; and after a further lapse of time, the coagulation of the fibrine apparently attains its maximum: this process, however, is not really completed until from twelve to thirty-six hours. We then find a firm red clot immersed in a yellowish liquid. The fibrine during its coagulation entangles a large number of the corpuscles, which impart to it the red colour; this is greatest towards the lower part of the clot. The liquid from which the clot has separated, the serum, also contains some of the globules in suspension; most of those not entangled in the clot, however, subside to the bottom of the vessel. The sp. gr. of the serum is about 1030. The appearances presented under the microscope by a drop of coagulating blood are very interesting. If examined immediately after removal from the body, the corpuscles are seen to be diffused irregularly over the field; but after the lapse of about a minute, the red corpuscles unite by their broad surfaces, gradually arranging themselves into rows resembling strings of figs; these interlace, forming an irregular red network, within the meshes of which the colourless corpuscles are seen (Pl. 49. fig. 37). The latter remain isolated, having no tendency to unite with the former. To observe these phenomena, the thin glass covering the drop of blood must not be pressed down; otherwise the free motion of the corpuscles will be impeded. After a time, the fibres break up, and the corpuscles float separately in the serum.

The coagulated fibrine is also seen distributed over the field, partly in a granular form, but mostly in that of a network of very delicate fibres. Sometimes the running together of the red corpuscles begins to take place immediately the blood has left the body, and the rows are seen to be formed very much more rapidly than in the healthy fluid; and when this is the case, the upper surface of the clot will be found to be free from the red colour, and more or less cupped or concave: this upper layer is called the buffy coat, and is in general a sign of inflammation. Considerable doubt still exists in regard to the nature of this buffy coat. It is also met with in blood which has been covered with a layer of oil before coagulation. But in the natural state it arises from the subsidence of the corpuscles before the commencement of the solidification of the fibrine, whereby the particles of the latter are brought into closer contact, thus allowing of its greater contraction. Certain salts prevent the separation of the fibrine in the form of fibres, and cause it to assume the form of minute granules or globules.

In addition to the corpuscles above described which are constantly found in the blood, it sometimes contains globules of oil, and, after meals especially, two distinct kinds of a white, extremely fine, molecular substance—one consisting of fat, the molecular base of the chyle, the other a very finely divided albuminous substance. They render the blood milky in appearance. The distinction of the muscular base of the chyle from the molecular albuminous deposit must be effected by ether, which dissolves the latter but not the former; but great care is requisite in judging of the action of ether.

Some methods have recently been devised for the enumeration of the blood-corpuscles. Malassez uses a glass tube, having a capillary bore with a dilatation near the upper end, in which is placed a glass globule. To this end is attached an india-rubber tube; the other end is pointed. The tube is accurately graduated. An artificial serum is made of gum acacia and water, or a saline solution of known strength. The point of the tube is then inserted in the blood to be examined, and a certain quantity is sucked up. A measure of the serum is then drawn in, and the apparatus well shaken. The corpuscles are thus spread through the serum so as to be diffused and readily counted. For this purpose the mixture is introduced into a capillary tube fixed to a slide, and the number of corpuscles read off by the aid of a micrometer eye-piece. The proportions of the dilution must necessarily be carefully taken into account. The colourless corpuscles can be enumerated in the same manner. Further details will be found in Robin, *Micr.*, 477 (figs.); or Rutherford, *Hist.*, 62 (figs.).

The colour of the blood of the Vertebrata varies according to whether it is removed from the arteries or the veins, in the former case being of a much lighter and brighter red than in the latter. It is beyond our province to enter into the details of the causes of their difference; suffice it to say, that it arises principally from an alteration in the globules, by which they are enabled to reflect light more copiously.

In the Invertebrata the coagulation of the blood is imperfect, and the clot much less firm and copious than in the Vertebrata.

The uses of the blood scarcely require mention. It is at the same time the nutritive fluid from which all the tissues of the body are formed and renovated, and that in which the components of the secretions are produced and from which they are separated. The red particles are subservient to the purposes of respiration; they are most numerous in those animals in which the respiratory function is most active, and which consume the largest proportion of oxygen, as birds and mammalia.

Development of the Coloured Corpuscles.—In the Vertebrata, two sets of coloured corpuscles are developed. The first, or embryonic blood-corpuscles, exist alone, until lymph and chyle begin to be formed, when they are gradually superseded by the second.

The first blood-corpuscles are formed from colourless nucleated cells with granular contents, identical with the formative cells of the embryo, by their losing the granules and becoming filled with hæmatine. These coloured, nucleated, primary blood-cells, which are spherical, larger and more deeply coloured than the coloured blood-corpuscles of the adult, form, with the colourless formative cells, the only elements of the blood. Soon, however, many of them begin to increase by division (Pl. 49. fig. 36), becoming elliptical and flattened, and closely resembling the coloured corpuscles of Reptiles, producing two, rarely three or four roundish nuclei, and then becoming resolved into two, three, or four new cells by the formation of one or more annular constrictions. These corpuscles then gradually lose their nuclei, become flattened and excavated laterally, and form perfect coloured corpuscles.

The formation of the second set, or those produced after birth and in adults, is more obscure. The most probable view appears to be that they are produced from the lymph and chyle-corpuscles, or certain corpuscles in the spleen and liver, by their losing their nuclei, becoming flattened, and producing hæmatine. At all events, corpuscles apparently identical with the so-called proper corpuscles of the chyle, surrounded with a membrane which is more or less distended with a red liquid, are met with in the chyle and lymph, and occasionally, but rarely, in the blood itself. Physiologists are not agreed as to the above views; but the preponderance of evidence appears decidedly in their favour. Recklinghausen has directly observed the conversion of the colourless corpuscles of the frog into the coloured corpuscles.

As unusual constituents of blood, may be mentioned:—

1. Cells or masses of protoplasm enclosing coloured blood-corpuscles; found in the blood of the spleen, liver, &c.
2. Granule-cells, either colourless or containing granules of pigment.
3. Peculiar concentric bodies, three or four times as large as the coloured corpuscles of the blood, resembling those found in the thymus gland.
4. An unusually large number of colourless corpuscles in Leucocythæmia.
5. Pus-corpuscles.
6. Caudate cells, sometimes containing pigment.
7. Crystals of hæmatoidine, sometimes

within the coloured corpuscles, at others free; also crystals of hæmoglobine (hæmatoglobuline).

8. The two molecular substances previously mentioned.

9. Hæmatozoa. *Filaria hominis*; other species in the deer, dog, rat, &c.; *Bilharzia*.

10. Hæmatophyta. *Bacteria, Bacilli*; *Spirochæte* (relapsing fever).

11. Altered colouring matter of the blood, forming minute rounded or angular black particles, contained in the colourless corpuscles; in splenic disease, and malaria.

It sometimes becomes of importance to be enabled to determine the presence of blood in supposed blood-spots, &c., and to distinguish that of man from that of animals. As regards the former point, it is a matter of no great difficulty. When blood has been dried at ordinary temperatures, the dried serum and contents of the corpuscles redissolve on digestion with cold water; and this is the condition under which the blood is generally presented for examination in such cases. We then have the fibrine left undissolved, which may be tested as to its chemical and microscopical characters (FIBRINE). The liquid is decolorized by boiling, and the coagulum assumes a brown colour (HÆMATINE). It also contains iron, is unaltered in colour by solution of potash, and contains a proteine compound. In heating very minute quantities upon a glass slide, the liquid must always be covered with a slip of thin glass, to prevent its drying. The mere presence of blood can thus be chemically determined without much difficulty; for these reactions may be observed under the microscope in a very minute quantity; but the distinction of small quantities of the blood of man from that of animals by chemical means, is impossible. We have therefore only the morphology of the elements or the spectral analysis to decide from. The portions of blood presented for examination will be almost invariably in a dried state; and the red corpuscles, when dried in a very thin layer, retain so nearly their natural size and outline, that any kinds of blood which are distinguishable in the fresh state, are certainly so when dried; but it will seldom happen that the blood will be dried upon a transparent substance, and in thin layers, permitting of its examination by transmitted light. It must therefore be separated from some fabric or structure, and restored as nearly as possible to its original appearance. This can be done by digesting the blood in a solution of bichloride of mercury, Robin's liquid (p. 106), or a $\frac{3}{4}$–1-p. c. salt-solution, and placing it under a bell-glass for some hours; the red corpuscles may then be detached with a camel's-hair pencil, and examined. Of course, only those corpuscles should be measured which evidently retain their natural form. The red corpuscles of the mammalia are readily distinguishable from those of the lower classes in the animal kingdom by their circular discoidal form and the absence of a nucleus; but those of individual groups can only be recognized by a difference in size. And great difference of opinion exists as to whether the blood-corpuscles of man can be distinguished from those of other animals. This point has been particularly discussed by Richardson, *Am. Jn. Med. Sc.* 1874, 102 (*M. M. Jn.* 1874, xii. 130); and Woodward, *M. M. Jn.* 1875, xiii. 65.

Virchow recommends that the blood-spots be mixed with dried and powdered chloride of sodium; next, that glacial acetic acid be added, and the mixture evaporated at 212°, when the blood-crystals (chloride of hæmatine) are abundantly deposited.

We should recommend those who are likely to undertake such investigations to make their own table of sizes; for it curiously happens that in general the size of the same objects given by different observers varies considerably. This arises probably from using too low a power, want of practice, and the use of a false standard. And we should not advise any one to attempt to form a judgment in a judicial question of this kind except he be thoroughly acquainted with the use of the microscope and micrometric investigations and the most difficult spectroscope, and has made numerous experiments upon this special point.

The corpuscles of the blood are best studied while existing in the serum of that liquid; but the white of egg neutralized with acetic acid exerts but little action upon them, as is also the case with a solution of bichloride of mercury. The colourless corpuscles are most easily recognized when the blood has been mixed with water.

They are best preserved when dried in a very thin layer upon a slide—a drop of blood being placed upon the slide, and the latter placed in a perpendicular position, so that a very thin layer will remain; in the liquid state, a solution of 1 part of bichloride of mercury, and 2 of chloride of sodium, in

200 parts of water, will preserve them well (Robin).

Bibl. Kölliker, *Hand. d. Gewebel.*; the Manuals on Physiology, by Müller, Valentine, Wagner, Carpenter, Forster, and Kirkes; the Dictionaries of Todd and Bowman, and Wagner; Hassall, *Micr. An.*; Gulliver, *Gerber's Anat.*; *Ann. N. H.* xvii.; *Pr. Zool. Soc.* 1862, p. 91; Schmidt, *Diagnostik verdächtiger Flecke*, &c. 1848; Frey, *Histologie*, and the copious Bibl. therein; Browning (*Spectroscope*), *Mn. Mic. Jn.* ii. p. 116; Rollett, *Stricker's Handb.* i. p. 574; Cornil and Ranvier, *Hist. path.*; Rutherford, *Hist.*; Beale, *How &c.*; Ralfs, *Action of Chloral hydrate, Chloroform, and Prussic acid on* (*M. M. Jn.*, 1871, vi. 75); Sorby, *M. M. Jn.* 1871, vi. 9 (*Spectroscope*); Richardson, *ibid.* 1876, xv. 30 (*Sp.*); Carpenter, *Micr.* 107; Beale, *How &c.* 273; Osler, *M. M. Jn.* 1874, xii. 141; E. Hart, *Qu. Mic. Jn.* 1881, xxi. 132 (*enum.*); Klein, *Hist.*; Lewis, *Qu. Mic. Jn.* xix. 245 (*Hæmatozoa*); *ibid.* 1879, 109 (*Rats*); *ibid.* xix. 356 (*Microphytes*); Norris, *Jn. Mic. Soc.* 1880, iii. 229; Dowdeswell, *Qu. Mic. Jn.* 1881, xxi. 154.

BLOOD ON BREAD.—Bread, flour, paste, and similar substances are sometimes attacked by a fermentation-fungus, which produces patches of a blood-red (or sometimes of an amber) colour. Most authors attribute the plants to *Oidium*, or to forms of *Penicillium*. Ehrenberg observed only minute corpuscles, which he called *Monas prodigiosa*. We have found these patches on sour paste, of red and yellow colour, consisting of isolated oval cells not more than 1-3000″ in diameter; and they were associated with *Penicillium glaucum*, of which they are probably a conidial form. This form is called *Cryptococcus glutinis* by Fresenius, who thinks it distinct from the so-called *Monas prodigiosa* of Ehrenberg, which he found in the form of corpuscles about 1-24000 to 1-48000″ in diameter. Montagne regards the plant as a *Palmella* (*prodigiosa*); and H. C. Stephens is of the same opinion. Cohn rightly refers this organism to *Micrococcus*.

This substance sometimes occurs on decaying Fungi. The blood-rain on damp wall-paper, calico, and old gourds and melons, is the mycelium of a species of *Epicoccum*.

Bibl. Ehrenb., Fresenius, *Mycologie*, Heft ii. p. 78; Desnon, *Mém. Soc. d. Sc. Nat. de Cherbourg*, iv. p. 19; Montagne, *Compt. Rend.* 1852; *Ann. N. H.* 2 ser. x. p. 309; Berkeley, *Crypt. Bot.* p. 264; Stephens, *Ann. N. H.* 1853, xii. p. 409, pl. 17.

BLOOD-VESSELS. See Vessels.

BLOOD-WORM.—The larva of *Chironomus plumosus*.

BLOXAMIA, Berk. and Br.—A genus of Sphæronemei (?) (Stylosporous Fungi), consisting of minute punctiform sacs, soon bursting above, containing closely packed tubes producing each a row of squarish spores. An anomalous genus, allied to *Cystotrichia* and *Myxormia*. *B. truncata* has been found on dead Wych elms.

Bibl. Berk. & Broome, *Ann. N. H.* 2 ser. xiii. 468, pl. 16. fig. 17; Berk. *Crypt. Bot.* 329.

BLYTTIA, Endlich.—A genus of Pelliese (Hepaticæ) founded on the *Jungermannia Lyellii* of Hooker, remarkable for the double envelope of the fruit, the outer being very short, dentate and laciniated, while the inner forms a largish, somewhat plaited cylinder. The antheridia arising from the rib are covered by incumbent scales, which are sometimes much laciniated and crowded together, sometimes (*J. hibernica*, Hook. *Brit. Jungerm.*) scarcely toothed, lax and larger.

Fig. 62.

Blyttia Lyellii, magn. 2 diam.

Bibl. Hooker, *Br. Jung.* t. 77 & t. 78; Nees, *Lebermoose*, iii. 313; *Flora Danica*, t. 2004.

BO'DO, Ehr.—A genus of Infusoria, belonging to the family Monadina. (Monads with a tail.)

Char. A tail; no eye-spot present; mouth terminal; animals sometimes united in the form of a mulberry or a bunch of grapes.

Ehrenberg describes eight species.

Some of them inhabit the intestinal canal of frogs, insects, &c. One is green, the rest are colourless.

Dujardin regards one species (*Bodo grandis*) as comprising both his *Heteromita ovata* and a species of *Anisonema*; the others he considers imperfectly examined species belonging to his genera *Cercomonas* and *Amphimonas*.

Bodo grandis, E. (*Heteromita ovata*, D.).

Fr. wat.; length 1-940 to 1-720″ (Pl. 30. fig. 18 *a*).

Bodo socialis, E. (Pl. 30. fig. 18, *b*, *c*). Fr. wat.; length 1-3000″.

Bibl. Ehrenberg, *Inf.*; Dujardin, *Inf.*; Pritchard, *Inf.*; Kent, *Inf.* 254.

BŒHME'RIA. Jacq.—A genus of Urticaceous plants closely allied to our common Stinging Nettle, and characterized, like that and other species of *Urtica*, by containing tenacious liber-fibres. Two species are employed in the East Indies on this account. *B. nivea*, Gaudichaud, yielding the fibre from which Chinese grass-cloth (Pl. 28. fig. 25) is manufactured, is a native of China, where it is largely cultivated, also in Sumatra, where it is called Caboose, and at Pulo Penang, where it is called Rami. *B. Puya*, Wallich, yields the Pooah or Puya fibre of Nepaul and Sikkim (Pl. 28. fig. 26), which has long been extensively used in India, and is said to equal the best European flax when properly dressed; being ordinarily roughly prepared, it is dirty and bad-coloured, but makes excellent sail-cloth and cordage.

Bibl. Hooker, *Jn. of Bot.* i. & iii.

BOLACOTRICHA, Berk. & Broome.—A genus of Mucedines (Hyphomycetous Fungi), containing one species, *B. grisea*, found growing upon dead cabbage-stalks, old mats made of *Typha*, &c., in tufts forming large, effused, grey patches. Messrs. Berkeley and Broome express themselves doubtfully as to its real affinities. In habit it approaches *Myxotrichum*, but differs in its simple threads and large spores, while the spores are not in chains as in *Sporodum*, or minute and linear as in *Trichobelonium*. The threads are pale purple under the microscope, strongly curved at the tips like tendrils.

Bibl. Berkeley and Broome, *Ann. Nat. Hist.* ser. 2. vii. p. 97, pl. 5. fig. 4.

BOLETUS, Dill.—A genus of Polyporei (Hymenomycetous Fungi), consisting of pileate Fungi, or 'toad-stools,' often of large size, growing in woods. See Basidiospores.

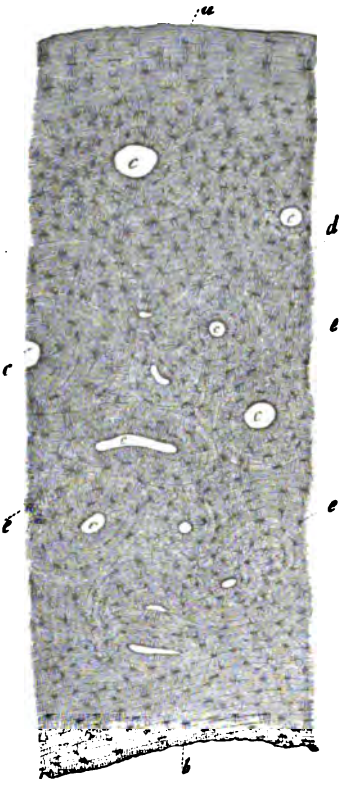
BOLIVINA, D'Orb.—A subdivision of the Bulimine Foraminifera, in which the peculiar infolded notch-like aperture is retained; but the chambers grow bilaterally alternate (Enallostegian), instead of triserial and obliquely spiral (Helicostegian), as in *Bulimina* proper. The shell is delicate and porous. *B. punctata* and *B. costata* are the two leading forms. Varieties are common in all seas, and date from the Cretaceous period.

Bibl. D'Orbigny, *For. Foss. Vien.* 239; Carpenter, *Introd. For.* 196.

BOMBA'CEÆ.—A subdivision of the family of Dicotyledonous plants called Sterculiaceæ, some genera of which are called Silk-cotton trees, from the long hairs which envelope their seeds, as in the true cotton plants. These hairs (from *Chorisia speciosa*, *Bombax*, sp. var., *Eriodendron*, sp. var.) cannot be spun, but are used for stuffing cushions, &c. The *Adansonia*, or Baobab-tree, produces a pulpy fruit, which contains a considerable proportion of starch. The wood of some kinds, as of *Bombax pentandra* and *Pachyra* (*Carolinea*) *minor*, is remarkable for its lightness and almost corky texture, resulting from being composed almost exclusively of parenchymatous cellular tissue, with scattered porous ducts and true wood-cells. See Wood.

BONE.—It need scarcely be stated that

Fig. 63.



Magnified 90 diameters.

Segment of the transverse section of a human metacarpal bone. *a*, outer surface of the bone, with the outer laminæ; *b*, inner surface next the medullary canal, with the inner laminæ; *c*, orifices of the divided Haversian canals, with their laminæ; *d*, interstitial laminæ; *e*, lacunæ, with their canaliculi.

bone is the hard substance serving to give firmness to the bodies of the Vertebrata, to protect their delicate organs, and to form points of attachment for muscles.

To the naked eye, bone appears to consist of an apparently homogeneous basis, surrounding certain cavities, areolæ or *cancelli*; these are most numerous and larger towards the centre, where, in the Mammalia and Birds, they form a larger cavity called the medullary canal. This contains the marrow in the former class, but air in the latter. Hence we recognize in bone an outer compact and an inner spongy portion.

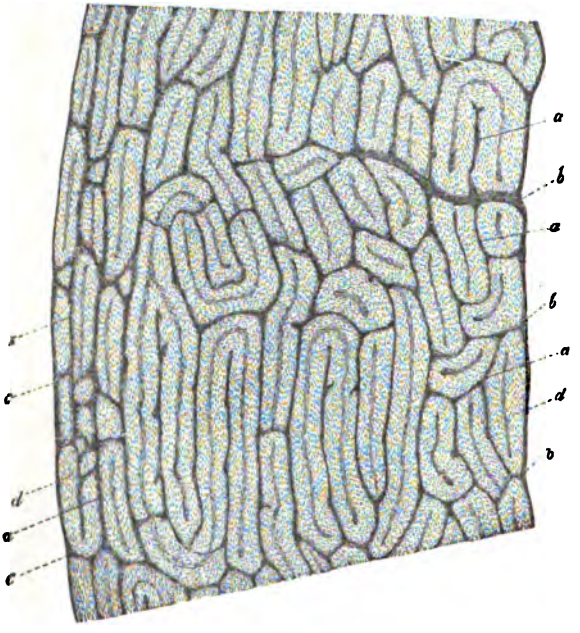
Fig. 64.

Magnified 60 diameters.

Haversian canals from the superficial layers of a human femur, at eighteen years of age, treated with muriatic acid. *a*, Haversian canals; *b*, osseous substance with lacunæ.

On examining a thin transverse section of bone under the microscope by transmitted light and with a low power, it is found to exhibit a number of round or oval apertures; these are the orifices of the divided vascular or *Haversian* canals (fig. 63 *c*). These canals contain blood-vessels in the natural state. They are cylindrical, sometimes flattened, communicate freely with each other and the medullary canal, and also open upon the outer surface of the bone. They mostly run parallel with the axis in the long bones; whilst in the flat bones they are parallel to the surfaces, frequently following a radiating course. The branches by which they communicate with each other are either transverse or oblique, and pursue a radiating or tangential course.

Fig. 65.



Magnified 25 diameters.

Segment of a transverse section of the shaft of the human femur, at eighteen years of age. *a*, Haversian canals; *b*, their internal orifices; *c*, the external orifices; *d*, osseous substance, with lacunæ. There are no transverse sections of the Haversian canals, nor concentric laminæ.

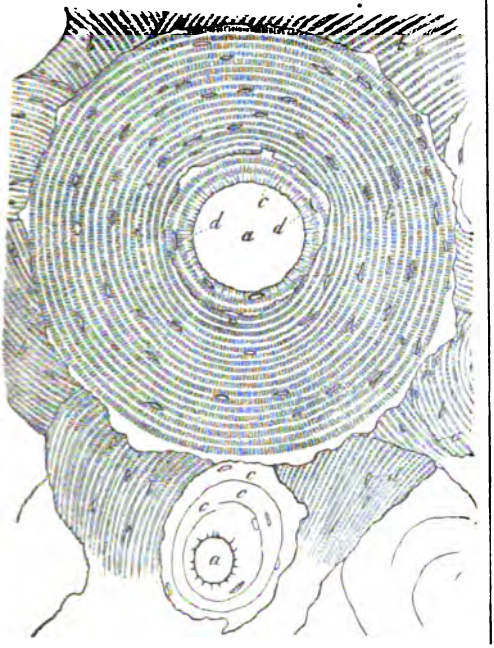
Hence in a longitudinal or superficial section of bone, the canals are seen running longitudinally, here and there connected by anastomosing branches, and forming elongated somewhat rectangular meshes (fig. 64).

In transverse sections of fœtal and incompletely developed bones, scarcely any of the apertures are met with, but the canals are seen pursuing a tangential or radial course (fig. 65 *a*); so that the bones appear to consist of short thick layers, each of which belongs to two canals, which separation is also indicated by a faint median line in each layer.

The Haversian canals vary considerably in size, from about 1-1000 to 1-200″.

The osseous substance or basis of bone possesses a laminated structure. The laminæ are visible in sections of dried bone (fig. 63 *a*, *b*), but much more

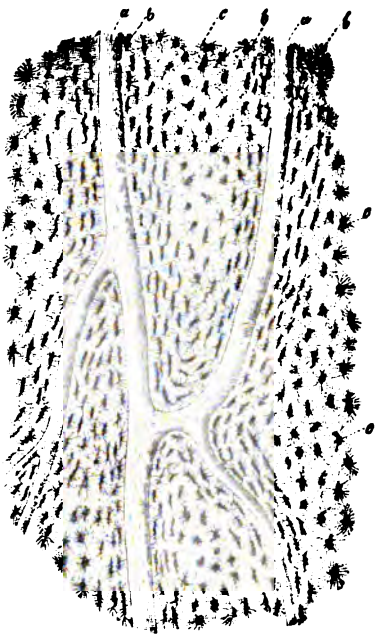
Fig. 66.



Magnified 250 diameters.

Portion of a transverse section of the shaft of the humerus, treated with oil of turpentine. *a*, Haversian canals; *b*, their laminæ, each lamina with a lighter and a darker portion, and radiating striæ in the latter; *c*, darker lines, probably indicating greater interruptions in the deposition of the osseous substance; *d*, lacunæ without evident canaliculi.

Fig. 67.



Magnified 100 diameters.

Section of the surface of the shaft of the femur. *a*, Haversian canals; *b*, side view of the lacunæ in the Haversian laminæ; *c*, surface view of lacunæ.

distinctly in bone from which the inorganic matter has been removed by digestion in dilute muriatic acid. In this the laminæ are easily separable. They frequently exhibit a fibrous appearance; and near the surfaces of the bones they run parallel with these surfaces (fig. 63 *a*, *b*); but in the other portions they mostly surround the Haversian canals concentrically (fig. 63 *d*).

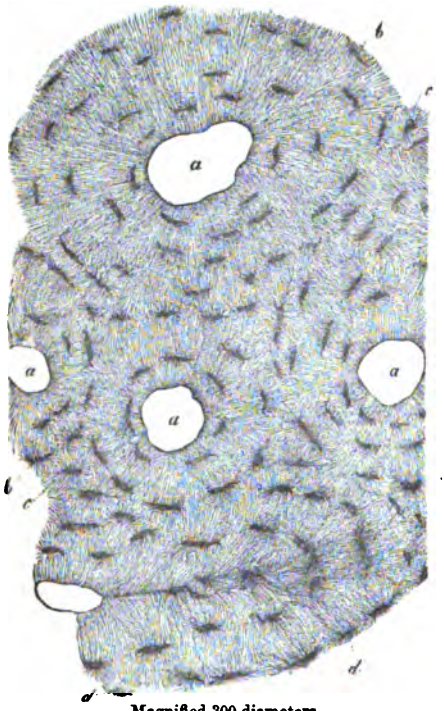
When a section of bone is examined with a somewhat high power, it exhibits numerous dark spots, with fine lines branching from them on all sides; the former are the *lacunæ*, bone-corpuscles, or bone-cells (fig. 67 *c*, *b*); and the latter are the *canaliculi* or calcigerous canals (fig. 68 *b*, *c*, *d*). They derive their dark appearance in dried bone from containing air: if this be displaced by immersion in oil of turpentine, they become so transparent as to be scarcely distinguishable (fig. 66); and when examined by reflected light, they appear white. The lacunæ are generally longer than broad, and flattened. They are about 1-1100″ in length, 1-2000 to 1-2800″ in width, and 1-3800 to 1-6000″ in thickness; but their dimensions are subject to great variety. The canaliculi vary in breadth from 1-20,000 to 1-60,000″; and at their narrowest part, which is furthest from the lacunæ, they anastomose with those of the adjacent lacunæ.

The walls of the lacunæ and canaliculi consist of a homogeneous calcified membrane.

In a transverse section of bone, the lacunæ of the laminæ surrounding the Haversian canals are seen to be placed tangentially to the orifices of these canals, as in figs. 66 and 68; whilst those of the laminæ near the surfaces are parallel with these surfaces (fig. 63).

In a longitudinal section made through the Haversian canals, they appear arranged

Fig. 68.



Magnified 300 diameters.

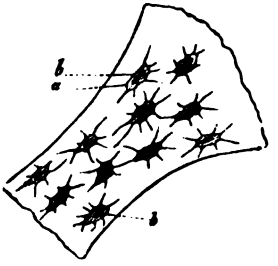
Part of a transverse section of the shaft of the humerus. *a*, Haversian canals; *b*, *c*, *d*, lacunæ with their canaliculi.

Fig. 69.

Magnified 350 diameters.

Portion of the outer surface of the tibia of a calf. The dots represent the orifices of the canaliculi, the larger dark indistinct spots are their lacunæ seen through the osseous substance.

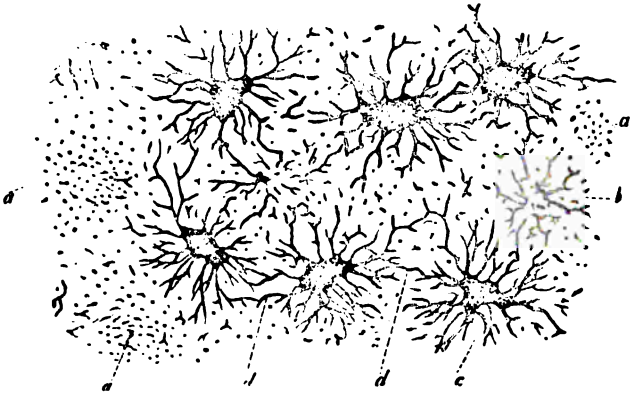
Fig. 70.



Magnified 350 diameters.

Cartilage of bone, after boiling in water. *a*, lacunar corpuscles; *b*, nuclei.

Fig. 71.



Magnified 450 diameters.

Lacunæ (surface view) with the canaliculi, from the parietal bone. The dots seen upon or between the lacunæ represent divided canaliculi, or their orifices opening into the lacunæ; *a*, *a*, *a*, groups of transversely divided canaliculi.

in numerous longitudinal rows running parallel with the Haversian canals (fig. 67). The general arrangement is, that the long axis of the lacunæ is parallel with the laminæ in which they are contained, or between which they are situated.

When the section coincides with the surfaces of a set of the lacunæ, they present a very elegant round or oval form (fig. 71), irregularly surrounded by a perfect tuft of canaliculi, which, being turned directly towards the observer, appear more or less shortened, and a small number of others, which are diffused through the surface of the lamellæ. Here and there, in the thinnest portion of the section, a group of transversely divided canaliculi is seen (fig. 71 *a*, *a*), without the lacunæ to which they belong, giving the substance a sieve-like appearance. At the outer and inner surfaces of the bones, the canaliculi terminate by open mouths (fig. 69); and those nearest the Haversian canals open into them.

Sharpey's perforating fibres are calcified pointed fibres, running from the periosteum towards the Haversian canals; they are irregular and variable, and are best seen in the bones of amphibia and fishes.

If the cartilage of bone be boiled for two or three minutes in water or a solution of caustic soda, the bone-cells or protoplasts and their nuclei are often rendered very distinct (fig. 70). After macerating bone in dilute muriatic acid also, the lacunar corpuscles, with longer or shorter processes, become isolated, and appear as independent formations.

In regard to the minute structure of bone, independently of the lacunæ and their canaliculi, a dry polished section exhibits a very delicate dotted appearance, which makes the bone appear granular, as if composed of closely aggregated pale granules, about 1-50,000 to 1-60,000″ in size. This is best seen in a transverse section.

When bone is calcined and the residue is rubbed between two pieces of glass, or when bone is digested in a Papin's digester, minute inorganic granules are left; these are oval or oblong, frequently angular, and are about 1-10,000 to 1-20,000″ in diameter.

Hence bone probably consists of an intimate mixture of organic and inorganic matter, in the form of minute, firmly united granules.

The above remarks apply to human bones; and those of the other Mammalia agree essentially in structure with the former.

In Birds, the Haversian canals are more numerous and smaller than in the Mammalia, and frequently run in a direction at right angles to the shaft; the lacunæ are also more numerous and smaller, and the canaliculi very tortuous.

In Reptiles and Amphibia they are few and very large, larger than in either of the other classes; the lacunæ and the canaliculi are also very large, and the latter very numerous.

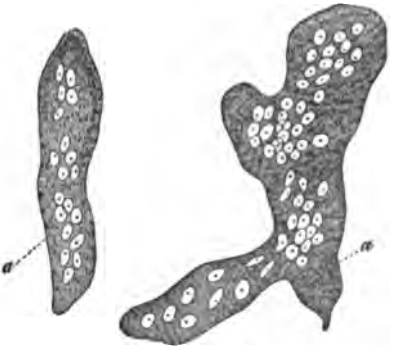
In Fishes, the structure is more irregular: there are no concentric laminæ; the Haversian canals are sometimes absent, at others very large and numerous; frequently the lacunæ are absent, whilst the canaliculi are unusually long and elegantly wavy and branched.

The structures representing the bones in the Invertebrata are noticed under the respective classes.

The marrow or medullary tissue of bones, consists of ordinary fatty tissue, free fatty matter, a particular liquid, and cells, with vessels and nerves, surrounded and traversed by a small quantity of areolar tissue.

In the fœtal or red marrow, numerous marrow-cells resembling the colourless corpuscles of the blood are met with; also some comparatively very large or giant cells, containing numerous nuclei (fig. 72): Kölliker's osteoclasts.

Fig. 72.



Magnified 350 times.

Giant cells, or Myeloplaxes, containing numerous nuclei, from the very young marrow of the flat bones of the human skull.

When animals, especially young ones, are fed with madder, the bones speedily acquire a beautiful red colour, principally around the Haversian canals, because it is here that

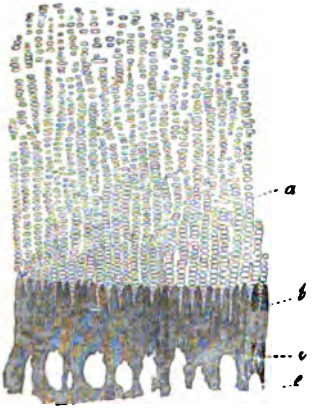
the process of formation of new bone is most active; and the earthy matter precipitated from the blood carries down with it the colouring matter of the madder.

The blood-vessels of bone which are distributed to the marrow (the nutrient vessels), enter particular canals on the external surface; whilst those connected with the Haversian canals are derived from the periosteum and from those of the marrow. The two sets anastomose freely.

Chemically, bone consists of gelatine (not chondrine, as in cartilage), with phosphate of lime, small quantities of carbonate of lime, carbonate of magnesia, fluoride of calcium, and sometimes a little oxide of iron and magnesia.

By digesting bone with dilute muriatic, chromic, or picric acid, the inorganic matter is removed, and by treatment with solutions of alkalies or incineration, the inorganic substance or so-called cartilage may be separated.

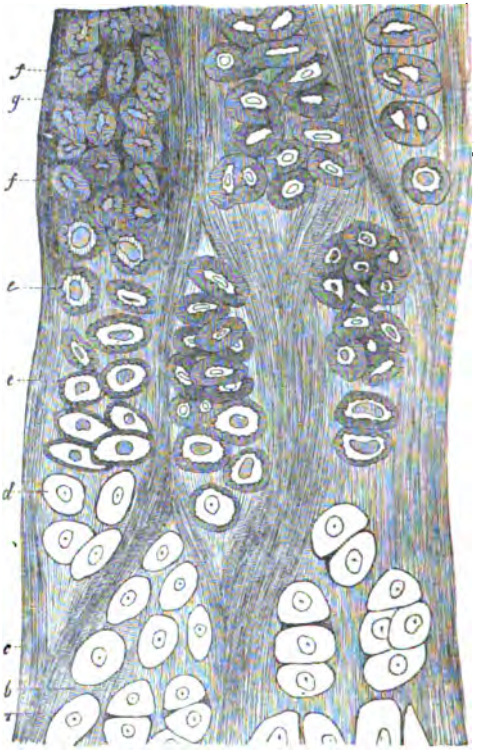
Fig. 73.



Magnified 20 diameters.

Perpendicular section of the margin of the shaft of the femur of a child, two weeks old, showing the calcification of cartilage. *a*, cartilage and its cells; *b*, margin of calcification; the dark stripes represent the calcification of the intercellular substance, which precedes that of the cartilage-cells, indicated by the lighter portions; *c*, compact calcified layer near the calcifying margin; *e*, cancelli formed by the absorption of the calcified substance.

Fig. 74.



Magnified 300 diameters.

Section of the margin of calcification of the condyle of the femur of a child two years old, affected with rickets. *a*, cartilage-cells, single and multiplying, in rows; *b*, *c*, more or less striated intercellular substance; *d*, cartilage-cells at the very commencement of secondary deposition; *e*, the same in a more advanced state, with greatly thickened walls, indications of the canaliculi, and commencing deposition of calcareous salts in the walls, hence their darker colour, the nuclei still distinct; *f*, still more developed and calcified cells imbedded in the intercellular substance *g*, which is also becoming calcified.

In the *development of bone*, first the cells of the (primary) cartilage multiply by endogenous cell-growth, forming longitudinal rows or irregular heaps. These fuse and liquefy, so as to produce canals and cancelli, in which blood-vessels and medulla are formed. Earthy matter is then deposited in the cartilage, in a finely granulated form (fig. 73); thus we have calcified cartilage —but not bone.

Absorption of the calcified cartilage next takes place, by which larger cancelli and canals are formed. Lastly deposition on the

walls of the cancelli and canals, of generations of stellate connective tissue corpuscles (osteoblasts), forming a pseudo-cartilage, occurs, which becomes calcified to form the true bone; the absorption of the calcified cartilage, and the deposition in its place of the new tissue, continuing until the structure of the bone is perfected.

But in certain bones, as the flat skull-bones, the jaw-bones &c., the bone is formed without the aid of cartilage. Here the inner surfaces of the periosteum produce the osteoblasts, which ultimately become the bone-corpuscles.

In certain morbid conditions, as in rickets, the development of the bone is arrested at the state of ossified cartilage; secondary deposit occurring in the cells of the primary cartilage as in the case of vegetable cells (fig. 74), the spaces left having great resemblance to the lacunæ and canaliculi of bone.

Adventitious bone agrees in general structure with the normal; and is met with in all stages of development.

To examine the structure of bone, thin sections are requisite. The method of making these is described under PREPARATION. By macerating bone in muriatic acid diluted with from 10 to 20 parts of water, or nitro-chromic acid, the inorganic matter is removed, the cartilage being left. Thin sections of this can then be readily made, and stained with picro-carmine or purpurine.

The canaliculi are not easily seen when sections of bone are immersed in liquids; for these fill them up. But it is a difficult matter to measure the lacunæ, unless the section be moistened with turpentine or other liquid.

Very thin sections may be preserved in the dry state; those which are thick may be mounted in inspissated Canada balsam, which does not easily enter the canaliculi, yet greatly increases the general transparency of the section.

BIBL. Kölliker, *Mikr. Anat.* ii.; Tomes, *Todd's Cycl. Anat. and Phys.*, art. *Osseous Tissue*; Quekett, *Tr. Mic. Soc.* 1846; Quain and Sharpey, *Anat.*; H. Müller, *Sieb. & Köll. Zeitschr.* ix. 147; Rutherford, *Hist.* 82; Schoney, *Sch. Arch.* xii. devel. (*M. M. Jn.* xvi. 1876, 67, figs.); Frey, *Histologie*, and the full BIBL. therein.

BONNEMAISO'NIA, Ag.—A genus of Laurenciaceæ (Florideous Algæ), bearing pear-shaped spores in stalked ceramidia.

B. asparagoides (Pl. 4. fig. 15) has a frond 4 to 12 inches long, growing near low-water mark or deeper, of delicate feathery character and deep crimson colour.

BIBL. Harvey, *Phyc. Brit.* pl. 51; *Br. Mar. Algæ*, p. 97, pl. 12 D; Greville, *Algæ Br.* p. 106, pl. 13.

BORACIC ACID is the acid of the well-known salt, borax, in which it exists combined with soda, in the proportion of two atoms of the acid to one of the base. Boracic acid is prepared by mixing three parts of borax dissolved in twelve parts of boiling water with one part of sulphuric acid or common oil of vitriol. As the mixture cools, the boracic acid separates in the crystalline form. It may be purified by re-solution in hot water, and subsequent cooling; finally, the crystals are pressed between blotting-paper, and dried. Boracic acid belongs to the doubly oblique prismatic system; and the crystals possess two optic axes. Those deposited from the hot aqueous solution are mostly six-sided plates; they exhibit the phenomena of analytic crystals, but at their lateral surfaces or edges only; and when their entire surface appears dark or coloured with the polarizer alone, the crystals are found to be laminated. But when an alcoholic solution of boracic acid is evaporated on a slide, or, still better, when some phosphoric acid is added to a solution of borax, and the mixture evaporated, minute disks or spherules of the acid are formed; these when carefully examined, are seen to be composed of minute needles radiating from a centre, exactly as in the oxalurate of ammonia. In some of them the needles are so closely in contact that they are undistinguishable and the circumference of the disk appears entire; in others, the free extremities of the needles are seen projecting beyond the circumference. They are perfectly colourless, and almost transparent when viewed by ordinary light, immersed in balsam. But when examined with polarized light, each disk exhibits the most beautiful cross and coloured rings, just as in the case of the oxalurate of ammonia, in which we have described the phenomenon more fully.

In some of the specimens of boracic acid the crystals form elegant arborizations, which also possess considerable analytic power.

The proportions of phosphoric acid and borax requisite to produce the disks cannot be laid down: they can only be prepared by accident in a number of trials. Even the same

solution will sometimes yield them, at others not. Drops of the solution should be placed upon a number of slides, and these laid upon a warm iron plate. The disks are much more beautiful than those of oxalurate of ammonia, appearing more transparent and the colours more brilliant, probably from their being more highly refractive. They are difficult also to preserve. Even when mounted in Canada balsam, they deliquesce after a time, and large crystals take their place.

BIBL. Fox Talbot, *Phil. Tr.* 1837; Brewster, *Optics*, 1853.

BORRE'RA, Ach., = PHYSCIA.

BOS'MINA, Baird.—A genus of Entomostraca, of the order Cladocera, and family Daphniadæ.

Char. Head terminated in front by a sharp beak directed forwards, and from the end of which project the long, many-jointed, curved and cylindrical superior antennæ; inferior antennæ two-branched, one branch with three, the other with four joints; five pairs of legs.

B. longirostris (Pl. 20. fig. 2). Superior antennæ with twenty joints. Fr. water.

BIBL. Baird, *Brit. Entom.* p. 105; Leydig, *Daphnid.* p. 244; Norman and Brady, *Br. Entom.* (*North. and Durham Trans.* i. p. 5).

BOSTRYCH'IA, Fries. See CYTISPORA.

BOSTRYCH'IA, Montagne.—A genus of Rhodomelaceæ (Florideous Algæ).

B. scorpioides. Frond purple, slender, branches involute at the end. Marine.

BIBL. Harvey, *Mar. Algæ*, 79.

BO'TACHUS, Brady.—A genus of Copepodous Entomostraca.

B. cylindratus.

BIBL. Brady, *Copepoda*, i. 140.

BOTHREN'CHYMA.—Pitted tissue of Plants. See TISSUE, Vegetable, and references under that head.

BOTHRIOCEPH'ALUS, Rudolphi.—A genus of Entozoa, of the order Sterelmintha, and family Cestoidea.

Char. Body long, flat, soft and jointed, joints short; head slightly tumid, oval or somewhat quadrangular, with two opposite depressions, or with four ear-like appendages, or with four depressions furnished with hooks; genital pores mesial.

The species are common in fish and birds, more rare in mammalia, and very rare in reptiles. They usually inhabit the alimentary canal, sometimes the abdominal cavity.

Thirty-four species are enumerated by Rudolphi, ten of which are doubtful. Dujardin enumerates twenty-three species.

Bothriocephalus latus (*Tænia lata*, the broad tape-worm) is met with in the human intestines. The head is somewhat ovoid, with two elongated opposite depressions, but no hooks; the neck generally not distinct. The joints of the body are very broad in proportion to their length. The orifices leading to the ovaries are situated in the centre of the flat surface of each joint; and around them the oviducts are seen, having a radiated or stellate appearance. Sometimes a minute body can be seen projecting from the genital pore—the male organ. It exclusively inhabits the small intestines. It is rare in England. It is 20 feet or more in length. Ova 1-350″ long. Embryos ciliated, with six hooks.

B. cordatus, with the head cordate, is found in dogs, and rarely in man (Leuckart, i. p. 438, fig.).

B. cristatus. With two prominences forming a papillate rostrum. Human; rare.

See TÆNIA and ENTOZOA.

BIBL. Rudolphi, *Entoz. Synops.*; Bremser, *Würmer*, &c.; Dujardin, *Helminth.*; Eschricht, *Die Bothr.*; Blanchard, *Ann. d. Sc. Nat.* 3 sér. xi.; Davaine, *Traité &c.*; Leuckart, *Parasit.* i. p. 416; Cobbold, *Parasites*, p. 106.

BOTRYCH'IUM, Swartz.—A genus of Ophioglossaceous Ferns. Moon-wort (*Botrychium Lunaria*) is an indigenous representative.

BIBL. Hooker, *Syn. Fil.*, p. 447.

BOTRYDI'NA, Bréb.—A genus of Palmelleæ (Confervoid Algæ). *B. vulgaris*, the only species (Pl. 7. fig. 9), forms a somewhat gelatinous, blackish-green stratum on the ground, on trees, or on mosses, in damp places.

The spores, about 1-10,000″ in diameter, increase by cell-division till they form spherical bodies composed of many cells, the peripheral layer of which is diaphanous, the internal green from granular contents; the internal vesicles multiply, with constant increase of size of the whole, until the little fronds acquire the dimensions of a pin's head (1-36″, Kützing); the whole cellular structure is firmly coherent.

BIBL. Brébisson, *Nouv. Genr. d'Alg.* (1839), p. 3, fig. 3; Meneghini, *Monog. Nostoch.* p. 98, pl. 13. fig. 2; Hassall, *Freshw.*

Algæ, 320, pl. 81. fig. 2; Kützing, *Tab. Phyc.* pl. 10; Rabenhorst, *Fl. Alg.* ii. p. 37.

BOTRYD'IUM, Wallr. (*Hydrogastrum*, Desv.).—A genus of Siphoneæ (Confervoid Algæ), of which one species is found in this country, growing upon damp, clayey ground, the dried-up bottoms of ponds, &c. A single plant, as developed from a spore or gonidium, exhibits a remarkable character, having a lower branched filamentous portion, growing in the ground, and an erect spherical or obovate portion, or head, about the size of a mustard-seed, of a bright green colour, the whole structure consisting merely of a single cell, with one continuous cavity running through the entire plant. The figure (fig. 75) represents such a specimen, with a second budding from it by vegetative increase; and in this way the plants come to form tufts or groups, like little bunches of grapes; hence the name. The cell-membrane acquires considerable thickness; and at the period when it is softening, and about to dissolve to allow of the escape of the gonidia, it is seen clearly to be composed of numerous lamellæ, like that of *Hydrodictyon*. The globular head is lined, in the full-grown specimens, with a layer of protoplasm (primordial utricle), containing abundance of chlorophyll-globules; and at a certain period breaks up into numerous free globular asexual *gonidia*.

Fig. 75.

Botrydium granulatum. Magnified 10 diameters.

When the air is dry, the protoplasm descends into the branches, in little masses, each forming a subterranean sporange, producing zoospores; which are also sometimes formed in a vesicle springing above ground, and capable of resisting desiccation.

Under the direct rays of the sun, the head-protoplasm breaks up into cells, at first green, then red. These, when free, produce biciliated zoospores, which copulate.

Bibl. Greville, *Algæ Br.* 196, pl. 19; Hassall, *Fr. Algæ*, 305, pl. 77. fig. 5; Kützing, *Nova Acta*, xix. pt. 2, pl. 69. figs. 1–10; Braun, *Verj.* (*Ray Soc.* 1853); Itzigsohn, *Bot. Zeit.* xiii. p. 257; Sachs, *Bot.* 275; Rostafinski & Woronin, *Bot. Zeit.* 1877 (*Qu. Mic. Jn.* 1878, xviii. 446).

BOTRYL'LIDÆ.—A family of Tunicate Mollusca. Distinguished by the individual bodies being united into a common mass, which is attached; and by the mantle being united to the test at the orifices only.

These animals form translucent gelatinous or cartilaginous masses, of various hues of orange, purple, yellow, blue, grey, and green; and are found under stones, or rocks, or incrusting sea-weeds, near low-water mark. The bodies are often arranged in elegant star-like clusters or systems; the anal orifices usually terminating in a common central cavity or vent. Genera:

Aplidium. Form variable; systems numerous; central cavity none; bodies with thorax, fore and hind abdomen; branchial orifice six-rayed; anal simple and indistinct.

Sidynum. Incrusting; systems conical, truncate and starred at the summit, centre depressed; thorax and abdomen present; branchial orifice eight-rayed.

Polyclinum. Form variable; systems numerous, convex and radiating, with central cavity; bodies with thorax, fore abdomen, and long-stalked hind abdomen; branchial orifice six-rayed; anal projecting horizontally.

Amaroucium. Lobed or incrusting, sessile or stalked; systems numerous, with a central cavity; bodies as in *Aplidium*.

Leptoclinum. Thin, incrusting; systems numerous; bodies with thorax and abdomen; branchial orifice six-rayed; anal opening into a common vent, more or less branched.

Distoma. Sessile; cartilaginous; form variable; systems numerous, circular; bodies in one or two rows at unequal distances from a common centre, with thorax and stalked abdomen; branchial and anal orifices six-rayed.

Botryllus. Incrusting, gelatinous; systems numerous; bodies horizontal, in stars round a common vent; bodies undivided; branchial orifice simple, remote from the vent.

Botrylloides. As the last, but stars irregular and ramifying; bodies vertical; orifices approximated.

Syntethys. Mass sessile, gelatinous, forming a single system; bodies sessile; orifices simple, without rays.

Bibl. See the Genera.

BOTRYLLOI'DES, M.-Edw.—A genus

of Tunicate Mollusca, of the family Botryllidæ.

Char. See BOTRYLLIDÆ.

Four species: *B. Leachii*, hyaline, purplish, stars mottled white and yellow; *B. albicans*, transparent, stars white; *B. rotifera*, yellowish, systems speckled with red; *B. rubrum*, intense orpiment-red.

BIBL. Gosse, *Mar. Zool.* ii. 34; Forbes and Hanley, *Brit. Moll.* i. 23.

BOTRYL'LUS, Gaertn.—A genus of Tunicate Mollusca, of the family Botryllidæ.

Char. See BOTRYLLIDÆ.

Six species: *B. Schlosseri* (Pl. 18. fig. 20), stars numerous, individuals ten to twenty or more, yellowish and reddish, common; *B. polycyclus*, stars numerous, individuals eight to twenty or more, bluish, general; *B. violaceus*, *B. smaragdus*, *B. bivittatus*, and *B. gemmeus*.

BIBL. Gosse, *Mar. Zool.* ii. 34; Forbes and Hanley, *Brit. Mollusc.* i. 19.

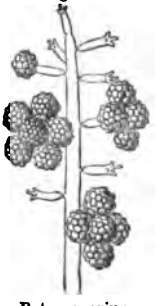
BOTRYOCOC'CUS, Kützing.—A genus of floating Palmelleæ (Confervoid Algæ), forming lobed and irregular bodies enclosed in a common, large, hyaline, membranous sac, about 1-24″ in diameter, and containing a number of ovoid cells 1-7000 to 1-5000″ in diameter, of a green or red colour.

B. Braunii. In lakes.

BIBL. Kützing, *Sp. Alg.* p. 892; Rabenhorst, *Fl. Alg.* iii. p. 42.

BOTRYOCYS'TIS, Kützing.—Described as a genus of Palmelleæ (Confervoid Algæ) found in stagnant fresh water, but apparently forms related to *Volvox*. See VOLVOCINEÆ.

Fig. 76.



Botryosporium pulchrum. A fertile filament bearing sporiferous lateral branches. Magnified 200 diam.

BIBL. Kützing, *Sp. Alg.* p. 208; *Tab. Phyc.* pl. 9 and 10; Braun, *Verjüngung*, &c. p. 170 (*Ray Soc.* 1853).

BOTRYOSPO'RIUM, Corda (*Stachylidium*, Fries).—A genus of Mucedines (Hyphomycetous Fungi) allied to *Botrytis*, but distinguished by the lateral position of the sporiferous branches (fig. 76). British species:

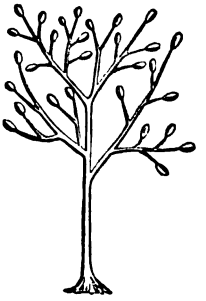
B. diffusum, Corda (*Stachylidium diffusum*, Fr., *Botrytis diffusa*, Greville), forms loose white tufts, a quarter of an inch high, on decaying herbaceous plants, especially potatoes.

B. pulchrum, Corda (fig. 76), forming mealy patches on living or decaying herbaceous plants.

BIBL. Corda in Sturm's *Deutschl. Fl.* iii.; *Prachtfl. Europ. Schimm.* p. 39; Greville, *Sc. Crypt. Fl.* t. 126. fig. 2; Currey, *Qu. J. Mic. Sc.* v. p. 117.

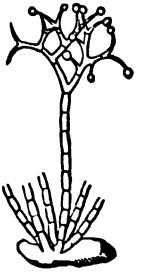
BOT'RYTIS, Mich.—A genus of Mucedines (Hyphomycetous Fungi), among which are found some of the commonest moulds of decaying vegetable substances, and some very important parasitic fungi. Corda separated the species with the filaments continuous into a genus *Peronospora* (fig. 77), from those with articulate fila-

Fig. 77.



Botrytis (Peronospora). Magnified 200 diameters.

Fig. 78.



Botrytis. Magnified 200 diameters.

ments (fig. 78). Among the remaining forms are distinguished species of varying habit, separated by some authors under the name of *Polyactis* and *Haplaria*. The Potato-fungus and the Muscardine of silkworms are species of Botrytis, as described below; their natural history is further treated of under the head of PARASITIC FUNGI. The following have been described as British species:—

B. (*Haplaria*, Lk.) *grisea*, Fr. Fertile filaments simple or forked, grey, slender, rather rigid, septate, with little heaps of globose grey spores at the apices and sides. On decaying vegetables, usually on *Sparganium* and allied plants. Corda, *Ic. Fung.* i. pl. 4. fig. 246.

B. (*Polyactis*) *cinerea*, Pers. Fertile filaments gregarious, almost simple, cinereous, soon strangulated, with white spores attached here and there. Not uncommon on stems of herbaceous plants.

B. (*Polyactis*) *cana*, Schmidt. Fertile filaments cinereous or whitish, branched at the apex; spores large, oval. On rotting stems and leaves. *Mucor racemosus*, Bulliard, t. 504. fig. 7.

B. (*Polyactis*) *vulgaris*, Fr. (fig. 263). Fertile filaments grey, divided at the apex into lobe-like branches, on which are collected the globose minute spores. Common on rotting plants. *B. acinorum*, Pers. Fresenius, *Beitr. z. Myc.* i. pl. 2 (?). *Polyactis vulgaris*, Nees, *Syst.* fig. 57.

B. vera, Fr. Fertile filaments grey, branched above, forming spikes about the slender apices. On decaying substances, fungi, &c. *Mucor Botrytis*, Bolton, pl. 132. fig. 3.

B. crustosa, Fr. Fertile filaments white, simple, trifid and verticillate; spores globose, terminal. On stems and leaves.

B. citrina, Berk. Mycelium white; fertile filaments erect, articulated, branched; branches subcymose, and, like the obovate spores, lemon-coloured. On dead branches of cherry-trees. Berkeley, *Ann. N. H.* i. p. 262, pl. 8. fig. 12.

B. terrestris, Pers. Fertile filaments white, quaternately divided at the tips, each tip bearing a single globose spore. On rotten sticks. Berk. *l. c.* pl. 14. fig. 24; *Stachylidium terrestre*, Grev. *Sc. Crypt. Fl.* pl. 257.

B. Jonesii, Berk. and Br. Fertile filaments erect, fawn-coloured, branched above; branches and branchlets divergent, mostly opposite, the last fasciculated, the centre always sterile and very acute; spores roundish, spiny. On dung. *Ann. N. H.* 2 ser. xiii. pl. 15. fig. 12.

B. Tilletii, Desm. Fertile filaments branched, fulvous; branchlets very short, whorled; spores subglobose. On mosses and various leaves. Desmaz. *Crypt. Exs.* fasc. v. No. 226; *Ann. d. Sc. Nat.* 2 sér. x. 308.

B. (*Peronospora*) *urticæ*, Libert, MSS. (Berk.). Fertile filaments greyish lilac, loosely divided above; branches forming an acute angle; extreme branchlets simple or forked, sometimes curved, rarely inflated; spores large, ovate, apex papilliform. On nettle-leaves. Berk. *Ann. N. H.* ser. 2, vii. p. 100.

B. (*Peronospora*) *parasitica*, Pers. Fertile filaments white; Branches ramulose; spores very large, globose. Caspary has found here cysts containing minute spores (*sporidangia*). On Cruciferæ (turnips, cabbages, &c.). Berkeley, *J. Hort. Soc.* i. pl. 4 fig. 26; Corda, *Ic. Fung.* v. pl. 2. fig. 18 *Mucor Botrytis*, Sowerby, pl. 359.

B. (*Peronospora*) *effusa*, Greville. Fertile filaments purplish-grey, branched above; branches short, divaricate; spores large, oval. Frequent on the lower face of leaves of spinach.

B. (*Peronospora*) *curta*, Berk. Fertile filaments simple, abbreviated, denticulate at the tips, grey-brown; spores oval. On *Anemone nemorosa*. Berk. *Ann. Nat. Hist. l. c.* pl. 8. fig. 13.

B. (*Peronospora*) *destructor*. Fertile filaments grey, erect, scarcely septate; branches alternate, the last forked, hooked, and divaricated; spores obovate, much attenuated at the base. Very destructive on species of *Allium* (onions &c.). Berk. *Ann. Nat. Hist.* vi. p. 436, pl. 13. fig. 23.

B. (*Peronospora*) *Arenariæ*, Berk. White; fertile filaments dichotomous above, divaricate-forked, not hooked at the tips; spores ovate. On the leaves of *Arenaria trinervis*. Berk. *J. Hort. Soc.* i. p. 31, pl. 4. fig. 22.

B. (*Peronospora*) *Viciæ*, Berk. White; fertile filaments sparingly branched, elongate; branchlets bifid, not hooked; spores obovate, apiculate. On common Vetches (a distinct species, purple, is said to grow on peas). Berk. *l. c.* pl. 4. fig. 23.

B. (*Peronospora*) *arborescens*, Berk. White; fertile filaments very much branched above, di-trichotomous, somewhat forcipate at the apex; spores smallish, subglobose. On common red-poppy leaves. Berk. *l. c.* pl. 4. fig. 24.

B. (*Peronospora*) *ganglioniformis*, Berk. White, in patches; fertile filaments branched above; branchlets curved, dilated in ganglioid thickenings below the tips; spores small, subglobose. On lettuces. Berk. *l. c.* pl. 4. fig. 25. *B. geminata*, Unger, *Bot. Zeit.* v. pl. 6. fig. 9. *Bremia lactucæ*, Regel, *Bot. Zeit.* 1843, i. p. 665, pl. 3 B.

B. (*Peronospora*) *macrospora*, Ung. Fertile filaments erect, several from the same point, white, branched above; spores very large, elongate-pyriform. On leaves of parsnips and other Umbelliferæ. Unger, *Exanthem*, pl. 2. fig. 14 B.

B. (*Peronospora*) *infestans*, Montagne (Pl. 26. figs. 5, 6). The Potato-fungus. This grows in tufts on the lower surface of the leaves, and also on the tubers of the potato, forming white mealy spots. The mycelium ramifies in the intercellular pas-

sages of the leaves, and sends out the fertile filaments from the stomata, so that these appear scattered among the hairs of the epidermis; they are usually about 1-30″ high upon the leaves, branched at the apex, septate and white. The 2 to 6 branches are erecto-patent, acute, virgate, nodose from numerous eliptical thickenings. The spores in large specimens are at first globular-ovoid, then elliptical, and finally somewhat of the shape of a gourd-seed, with a sub-apiculate mamilla at one end, very shortly pedicellate at the other, of the same colour as the filaments, chiefly white, densely filled with sporules enclosed in an endo-spore, about 1-800″ long, 1-1200″ thick. These sporules have been shown by De Bary to be zoospores when fully developed, moving about by means of two cilia. Besides the normal spores, there are resting-spores in many *Peronosporæ*, which have been described by the same author in *Ann. d. Sc. N.* 1863, xx. p. 10. *Artotrogus* of Montagne is probably the resting-spore of *Peronospora infestans*. Berkeley, *Jn. Hort. Soc.* i. 30, pl. 2–4. figs. 4–19. *Botrytis Solani*, auct., var. *B. fallax*, Desmazières. *B. devastatrix*, Libert; Morren, *Ann. de la Soc. de l'Ag. de Gand*, 1845, p. 287; *Peronospora trifurcata*, Unger, *Bot. Zeit.* v. 314, pl. 6. figs. 1–6; W. Smith, *M. M. J.* 1875, xiv. 110 (figs.).

Botrytis Bassiana, Balsamo, is the fungus growing in the bodies of silkworms, causing the disease called *Muscardine*, which sometimes produces most extensive destruction in the districts where they are cultivated. A figure of it is given by Mr. Berkeley in the paper on the Potato-fungus referred to above. Many papers on it exist in the *Comptes Rendus*; and the whole history, with figures, will be found in Robin's *Végétaux Parasites*, p. 560.

Botrytis lateritia, Fr., not uncommon in the hollows of decaying potatoes, beet-root, &c., appears to be a form of *Acrostalagmus parasitans*, Corda. See Acrostalagmus.

The genus *Botrytis*, like many other genera, has been divided and subdivided till the genus itself has almost vanished. It is restricted in the 'Outlines of British Fungology' to those species which have septate, hyaline or coloured threads, with terminal spores, as *B. Tilletii*, *citrina*, *Jonesii*, and *terrestris*. Several of the so-called species are states of Ascomycetous Fungi. See Tulasne, *Carpologia*, vol. iii.

Bibl. As given under the species. Fries, *Summa Veget.* p. 490; Berkeley, *Crypt. Bot.* p. 307.

BOUGAINVIL'LIA, Lesson.—A genus of marine Hydroid Zoophytes, family Atractylidæ.

Char. Stem branched, rooted by a filiform stolon; polypes fusiform; a single wreath of filiform tentacles around the base of the conical proboscis. 3 British species.

Bibl. Hincks, *Hydr. Zooph.* p. 108.

BOWERBAN'KIA, Farre.—A genus of Infundibulate Polyzoa (Bryozoa), of the suborder Ctenostomata, and family Vesiculariidæ.

Distinguished by the matted and creeping or erect and irregularly branched polypidom (polyzoarium), the tubular densely clustered cells, the eight to ten tentacles, and the strong gizzard.

B. imbricata (Pl. 18. fig. 19), the only species, has the cells ovate or ovato-cylindrical, in dense clusters irregularly scattered on the polypidom.

Parasitic on other Polyzoa, Polypi, and Algæ. Polypidom in the young state creeping and matted, and formerly regarded as a distinct species (*B. densa*); in the adult condition forming bushy confervoid flaccid tufts, an inch and a half high, much and irregularly branched. Branches smooth, transparent and hollow, cells aggregated on one side.

It forms a favourable object for the study of the structure of the Polyzoa, on account of its transparency.

Four other species.

Bibl. Johnston, *Br. Zooph.* 377; Farre, *Phil. Tr.* 1837, 391; Gosse, *Mar. Zool.* ii. p. 21; Hincks, *Polyzoa*, 518; Repiachoff, *Zool. Anz.* ii. 1879, 660 (*Jn. Mic. Soc.* 1880, iii. 238: embryol.).

BOX.—The wood of the box-tree, *Buxus sempervirens*, L. (Nat. Ord. Euphorbiaceæ, Dicotyledon), is remarkable for its hardness, offering a great contrast to that of *Bombax* and the like. See Wood.

BRACHIONÆ'A.—A family of Rotatoria.

Char. A carapace (testula) present; rotatory organs two, simple.

The rotatory organ sometimes appears to consist of five parts, three median and two lateral. The two larger lateral ones only are true rotatory organs, the cilia of the median ones remaining extended without motion during the action of the others. The carapace resembles that of a tortoise.

Genera :

Eye-spots absent; foot forked ..... *Notus.*

Eye-spots present { one { foot absent..... *Anuræa.* / foot forked..... *Brachionus.* } two { foot absent..... *Pompholyx.* / foot styliform .. *Pterodina.* }

See HYDROCORA and DIPODINA.

BRA'CHIONUS, Hill.—A genus of Rotatoria, of the family Brachionæa.

Char. A single eye-spot at the back of the head; foot forked.

The anterior margin of the carapace is furnished with teeth, as in some species is the posterior margin also.

B. amphiceros (Pl. 43. fig. 8). Carapace smooth, furnished both at the anterior and posterior margin with four teeth; aquatic; length 1-70''.

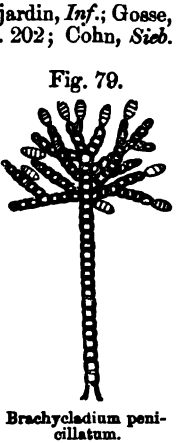
B. rubens. Carapace smooth, with six acute teeth in front, and rounded posteriorly; body reddish; aquatic; length 1-50'': teeth, Pl. 43. fig. 9.

Eleven other species have been described; some of them freshwater, others marine.

BIBL. Ehrenb. *Inf.*; Dujardin, *Inf.*; Gosse, *Ann. N. H.* 1851, viii. p. 202; Cohn, *Sieb. & Kölük. Zeit.* vii. p. 450.

BRACHYCLA'DIUM, Corda.—A genus of Dematiei (Hyphomycetous Fungi), not separated by any marked characters from DENDRYPHIUM; forming a delicate mould on dry stems of herbaceous plants. The filaments and branches are formed of squarish cells, swollen so as to produce a moniliform appearance, the walls being thick and coloured.

Fig. 79.



Brachycladium penicillatum.

An erect filament with fertile branches. Magnified 200 diameters.

The so-called species are probably stages of Ascomycetous Fungi.

B. penicillatum, Corda, is said to extend over stems, sometimes in tracts a foot long; the filaments and branches are blackish, the spores white (fig. 79).

B. Thomasinum has been found in amber.

BIBL. Corda, *Ic. Fung.*; Fries, *Summa Veg.* p. 504.

BRACHYCO'LUS, Buckton.—A genus of Aphidæ.

B. stellariæ. Body mealy, very long and narrow. On *Stellaria holostea* and *Holcus mollis.*

BIBL. Buckton, *Aphides* (*Ray Soc*), ii. p. 146.

BRA'CHYODUS, Nees.—A genus of Leptotrichaceous Mosses, separated from *Gymnostomum* or *Weissia* of some authors.

BIBL. Wilson, *Bryol. Brit.* p. 52.

BRACHYSTE'LIUM, Reichb.—A genus of Orthotrichaceous Mosses.

Brachystelium polyphyllum, Hsch., = *Ptychomitrium polyphyllus*, Br. and Sch.

BIBL. Wilson, *Bryol. Brit.* p. 173.

BRACHYTHE'CIUM, Br. and Sch., = HYPNUM.

BIBL. Wilson, *Bryol. Brit.* p. 337.

BRA'DYA, Boeck.—A genus of Entomostraca (Copepoda).

B. typica. Anterior antennæ very short, 7-jointed. Scilly Isles.

BIBL. Brady, *Copepoda* (*Ray Soc.*) ii. p. 16.

BRADYCINE'TUS, Sars.—A genus of Entomostraca, of the order Ostracoda (section Myodocopa) and family Cypridinidæ. Characterized by the 2-branched lower antennæ, and the one pair of feet. *B. brenda* = *Cypridina brenda*, Baird; *B. Macandrei* = *Cyp. Mac.* B.

BIBL. Brady, *Linn. Trans.* xxvi. p. 466.

BRAIN. See NERVES.

BRAI'NEA, Hook.—A genus of Grammitideæ (Polypodiaceous Ferns), with continuous sori along transverse veins near the midrib, produced along the veins towards the edge of the frond.

The single species, *B. insignis*, is found at Hong Kong &c.

BIBL. Hooker, *Syn.*, p. 390.

BRAN. See CORN.

BRAN'CHIÆ.—This term is synonymous with gills. The latter term, however, is usually applied to the aquatic respiratory organs of fishes, whilst those of other animals retain the name of branchiæ. Their structure is described with that of the respective classes in which they occur. See also EPHEMERA and LIBELLULIDÆ.

BRAN'CHIPUS, Schæffer (*Chirocephalus*).—A genus of Entomostraca, of the order Phyllopoda, and family Branchipodidæ.

Char. Abdomen prolonged in the form of a tail, composed of nine segments or joints, the end joint with two well-developed plates or lamellar appendages; superior antennæ, in both sexes, slender, filiform, and many-jointed; inferior antennæ in the male large, curved downwards, two-jointed, furnished at the base with fan-

shaped and digitiform appendages; in the female stout, short, somewhat acute, slightly curved, and not furnished with appendages at the base.

B. stagnalis (Pl. 20. fig. 3). An inch in length; tinged with red.

This beautiful animal is found in stagnant water, as the ditches and deep cart-ruts on the edges of woods and plantations.

B. rubricaudatus, Kl. Ovarian sac and tail-fork red; the former long, cylindrical, terminating in a curved prickle.

In rain-water, at Kossier (Red Sea).

Bibl. Baird, *Brit. Entom.* p. 39; Klunzinger, *Sieb. & Köll. Zeitsch.* xvii. p. 23.

BRAND.—A disease of Cereal Grasses and other plants, depending on Fungi. See Blight.

BREAD.—The interest of the microscopic examination of bread depends chiefly on the impurities it may contain, or the peculiar Fungi-development in it during decay. The commonest intentional adulteration of bread is the addition of mashed potatoes to the flour; but it must be remembered, that potato-yeast is sometimes used to produce the fermentation of the dough. The cells of the potato are readily recognizable in bread after the starch has been dissolved and washed away. The adulteration of the flour with other meals, as corn-flour, rice, beans, &c., is easily ascertained before it is made up; but the baking greatly affects the form of the starch-granules. See Starch.

The spores of the parasitic Fungi of wheat (Uredinei, Ustilaginei), pollen-grains, and other vegetable bodies are occasionally met with as accidental impurities, and are present in large numbers in inferior and "damped" flours.

The fermentation of bread depends upon the development of the Yeast fungi in the dough: an account of this will be found under that head, and Fermentation.

Mouldy bread presents various microscopic fungi in a mature condition, some evidently the fruit of the yeast-plants, Penicillium, Mucor, &c.; others, like the so-called 'blood on bread,' appear to be peculiar states of the vegetative structure of the same Fungi.

Bibl. That of Adulteration; and Coulier, *Manuel &c.*; Robin, *Micr.* p. 922.

BRET'TIA, Dyster.—A genus of Cheilostomatous Polyzoa (Bryozoa), family Eucratiidæ. Two species: found between tide-marks, and in dredgings.

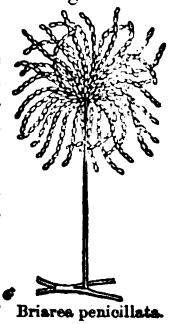
Bibl. Hincks, *Polyzoa*, p. 27; Dyster, *Qu. Mic. Jn.* 1858, vi. p. 260.

BREUTE'LIA, Br. and Sch., = Bartramia.

Bibl. Wilson, *Bryol. Brit.* p. 283.

BRIA'REA, Corda.—A genus of Mucedines (Hyphomycetous Fungi), nearly related to *Penicillium*, *Aspergillus*, and *Monilia*, distinguished from the first and last by the moniliform rows of spores arising, directly, in a terminal tuft, while the erect fertile filament is not expanded into a capitulum to bear them, as is the case in *Aspergillus*. British species:—

Fig. 80.



Briarea penicillata. Magnified 200 diameters.

Briarea penicillata (fig. 80), (*Monilia*, Fries, *Aspergillus*, Greville). The erect filaments are simple and geniculate, the spores hyaline, forming long nodding moniliform rows. It is of dark grey colour, and is found on damp grass, mouldy hay, straw, &c.

Bibl. Corda, *Ic. Fung.* v. 16, and in Sturm, *Deutschl. Flor.* ii. pl. 6; Greville, *Sc. Crypt. Fl.* t. 32; Berk., *Hook. Br. Fl.* 345.

BRIGHTWELLIA, Ralfs.—A genus of Diatomaceæ.

Char. Valves disk-shaped, with a large granulated centre, separated from a broad punctate limb by a ring of oblong cells.

B. coronata, *Mic. Tr.* viii. p. 95, pl. 5. f. 6; *B. elaborata*, ibid. 1861, i. p. 73; *B. Johnsoni*, ibid. 1866, vi. p. 4.

Bibl. Ralfs, *Pritchard's Infus.* p. 940.

BRINE-WORM. See Artemia.

BRISTLE. See Hairs.

BROMELIA'CEÆ.—A family of Monocotyledons (Flowering Plants), of which the Pine-apple, *Ananas* or *Ananassa*, is the most familiar example. This is interesting microscopically from the scurfy character of the epidermis of the leaves, dependent on peculiar cellular scales. The cells of the epidermis are of very elegant form (Pl. 47. fig. 15); and the fibres of the leaf are manufactured into very fine muslin. See Scales, Epidermis, and Fibres.

BRONCHI. See Lungs.

BRONCHIOCER'CA.—*Monocerca* with the caudiform foot cleft at the end. Five species have been described; but it appears

that they do not differ by well-marked characters from the species of *Monocerca*.

BIBL. Werneck, *Ber. Berl. Ak.* 1841, 377.

BROOKE'S APPARATUS. INTRODUCTION, p. xxi.

BRUCHIA'CEÆ.—A family of inoperculate Acrocarpous Mosses, gregarious or cæspitose and terrestrial, in which the fruit-stalks sometimes appear lateral, through arising from innovations. The stems dwarf, either simple or branched by innovations; the leaves lanceolate or awl-shaped from a more or less oval base, composed of parenchymatous cells, larger and sometimes lax at the base of the leaf, smaller and squarish toward the apex, and furnished with a flattened broad nerve (fig. 49), and standing up like bristles; the perichætial leaves broader at the base and sheathing; all of firm membranous character, shining and smooth. Capsules oval or globose, mostly straight-beaked (fig. 50). British genera:—

Archidium. Calyptra completely enclosing the (globose) capsule, bursting above. Inflorescence monœcious, bud-shaped.

Astomum. Calyptra dimidiate. Capsule equal. Inflorescence either monœcious, gemmiform and axillary, or with the antheridia and archegones together.

BRU'CHUS, Linn.—A genus of Coleopterous Insects.

B. pisi is a common small beetle; black, mottled with white. The larva feeds upon peas. Several other species.

BIBL. Stephens, *Brit. Coleopt.* p. 264; Boisduval, *L'Entomol. Horticole*, p. 157.

BRU'CIA. See ALKALOIDS.

BRYA'CEÆ.—A family of operculate Mosses, acrocarpous, or by innovation pleurocarpous, with lanceolate, oval, round, or spathulate leaves, composed of cells parallelogrammic below, rhomboidal - parenchymatous above, more or less dense, with much chlorophyll or a persistent primordial utricle, or at length empty, very smooth. Capsule more or less pear-shaped, clavate, oval or cylindrical, with a hemispherical or conical operculum, erect, nodding or pendulous. External peristome, when present, soft, lamellose, internal membranous. British genera:—

Fig. 81.

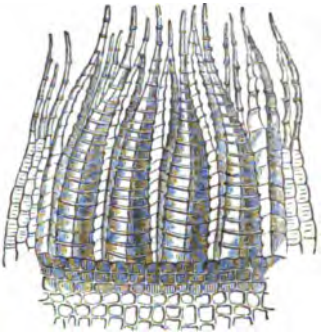
Mielichoferia nitida.
Teeth from the peristome.
Magnified 150 diameters.

Mielichoferia. Calyptra conical-dimidiate, split at the side. Peristome wanting or simple, then of sixteen equidistant, filiform, flattish, articulated pale teeth, sometimes placed on a short, sulcate, reticulate basilar membrane (fig. 81). Capsule lateral, with a double annulus.

Orthodontium. Calyptra smallish, hood-shaped, fugacious. Peristome arising below the orifice of the capsule, double; external: of sixteen lanceolate-subulate teeth, like those in *Bryum*; when dry, deflexed below the orifice of the capsule, when moistened, erect; internal: cilia alternating with the external teeth, half as long or about equal, filiform, from a short, somewhat keeled membrane. Capsule annulate or exannulate, with a longish collum.

Bryum. Calyptra dimidiate, smallish, hood-shaped. Peristome double (fig. 82);

Fig. 82.



Bryum intermedium.
A portion of the peristome.
Magnified 150 diameters.

external of sixteen lanceolate, soft, yellowish equidistant teeth, flat on the back and transversely trabeculated, with a flexuous longitudinal line in the middle, lamellate within, hygroscopic; internal a large delicate membrane with sixteen keels, produced into more or less perfect lanceolate teeth, often with intermediate cilia, sometimes without. Capsules mostly annulate.

BIBL. See MOSSES.

BRYO'BIA, Koch.—A genus of Acarina, family Trombidina.

Char. Legs 6-jointed; fore legs longest; eyes near the hind angles of the cephalo-

thorax; abdominal margin studded with short, somewhat triangular sparse papillæ.

B. speciosa.

Bibl. Koch, *Uebersicht*, 61; Murray, *Ec. Ent.* 117.

BRYOP'SIS, Lamouroux.—A marine genus of Siphoneæ (Confervoid Algæ), of which the British species form beautiful green, somewhat elastic, feathered silky tufts, from 1 to 4″ high upon rocks or upon other Algæ, in tide-pools. The whole axis and proper branches of each plant consist of one large ramified cell, the cavity being continuous throughout, the membranous wall rather thick, and somewhat gelatinous externally; the branches are naked below, but clothed above by small ramuli, arranged like leaves, distichously, spirally, or irregularly. The main axes and branches grow indefinitely by development of the apices; the ramuli are limited in their development, and they are ultimately shut off by septa, at last falling off by the circular rupture of their wall, just above their point of origin.

When examined early, the ramuli are found to have their walls lined with largish elliptical green grains, each of which has at first a round light central body, colourable blue by iodine when fully formed (starch-corpuscle). The branches exhibit the phenomenon of reproduction, in irregular order, in the following way. The green bodies on their walls multiply by subdivision, and increase in size and number until they completely fill the tubular cavity of the ramule, pressing upon one another so as to form a compound dark-green mass. A peculiar swarming movement is next observed in the green bodies, which increases more and more; and, the parent tube opening by a pore near its apex, the green bodies escape as elongated pear-shaped zoospores or active gonidia with cilia, according to Thuret, two and four in *B. hypnoides*, only two in *B. plumosa*. The successive emission of the gonidia from the various tubes of one plant occupies several days.

After the gonidia have come to rest, they acquire a spherical form, and gradually increase in size; at the end of a month or six weeks their diameter is twice or thrice the original dimensions; and then they begin to elongate into a tube similar to the parent. Agardh found them elongate, either in one direction or in two, at first; but one end soon swelled into a thickened organ of attachment, while the other began about the sixth week to branch. British species:—

B. plumosa, Huds. (Pl. 4. fig. 19). Deep green, 1 to 4 inches high, more or less branched; the branches pinnated with subopposite distichous or rarely irregular ramules. Harvey, *Mar. Algæ*, 2nd ed. pl. 24 B; *Phycol. Brit.* pl. 3; Greville, *Algæ*, pl. 19; *Engl. Bot.* (*Ulva plumosa*), 2375.

B. hypnoides, Lamour. Yellow-green, 2 to 4 inches high, more slender and more branched, branches repeatedly divided, ramules irregularly scattered, somewhat pinnate, more or less dense. Harvey, *Phyc. Brit.* pl. 119.

Bibl. Systematic, *as above*, and Kützing, *Sp. Alg.* p. 490; Physiology, &c., Agardh, *Ann. d. Sc. Nat.* 2 sér. vi. 200, pl. 12; Nägeli, *Zeits. wiss. Bot.* 1844–46 (*Ray Soc.* 1845, 269, pl. 6. figs. 11, 12; 1849, 97, pl. 2. figs. 1–3); *Neu. Algen-Systeme*, 1847, 171, pl. 1. figs. 44–56; Thuret, *Ann. d. Sc. N.* 3 sér. xiv. 8, pl. 16. figs. 1–6; Braun, *Verj.* 137 (*Ray Soc.* 1853, p. 120); Pringsheim, *Monatsber Berl. Akad.* 1871; Sachs, *Bot.* 275.

BRYOZO'A. See Polyzoa.

BRY'UM, Dill.—A genus of operculate Mosses, usually acrocarpous, containing a large number of British species, even in its restricted condition.

Among the most common of these are *B. nutans* (fig. 467), *cernuum*, *intermedium*, *capillare*, *cæspiticium*, &c. Many of the older species are now included under Mnium.

Bibl. Wilson, *Bryol. Brit.* p. 221.

BUC'CINUM, L.—*B. undulatum*, the common Whelk. The tongue forms an interesting microscopic object.

BUDS.—The buds of plants form interesting objects of microscopic investigation on many accounts,—first, in tracing the development of the organs, and also of the tissues of which these are formed; secondly, on account of certain temporary structures which they exhibit. The thick epidermis of the scales of the winter-buds of ordinary trees, as of the ash, &c., is a very favourable object for sections to show the character of this tissue when highly developed. The internal soft scales and young leaves of very many of these winter-buds, as well as other buds of herbaceous plants, are clothed with glandular hairs, which disappear when the buds are expanded; and these often afford advantageous material for studying cell-development. See Gemmæ.

BUG. See CIMEX.

BU'GULA, Oken (*Cellularia* part, Johnston).—A genus of Infundibulate Polyzoa (Bryozoa), of the suborder Cheilostomata, and family Bicellariidæ.

Distinguished by the elliptical closely contiguous cells in two or more rows, the very large orifice with a simple not thickened margin, and the stalked, jointed, frequently blue or red avicularia.

B. flabellata. Cells in many rows, oblong, truncate at ends, with one or two spines at upper angles; orifice extending to the base; avicularia on the sides of the cells capitate, surface smooth; ovicells cucullate, with a very wide orifice.

B. avicularia (*Cellularia avic.*, Johnston). Cells in two rows, elongate, contracted below; orifice not reaching quite to the base, obovate; with two spines on the outer side, and one on the inner above; avicularia lateral, capitate, surface granular or areolate; ovicells superior, subglobular: orifice small. Deep water.

B. plumosa. Cells elongate, narrowed below, with a spine at upper and outer angle; orifice as wide as the cell above, elliptical below; avicularia capitate, close to outer margin of the orifice; ovicell superior, globular.

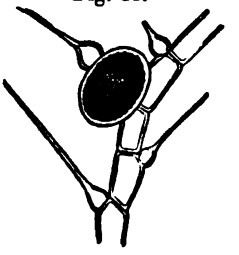
B. Murrayana (*Flustra Mur.*, Johnst.). Cells in many rows, narrowed about the middle and below; orifice oval, with one to four incurved marginal spines on the outer and one on the inner edge; a strong hollow spine on each side of the top of the cell, and a capitate avicularium on the front of some of the cells below the orifice. Very rare.

BIBL. Busk, *Mar. Polyzoa* (*Br. Mus.*), 43; Johnston, *Br. Zooph.*; Hincks, *Polyzoa*, 73.

BULBOCHÆTE, Ag.—A genus of Œdogonieæ (Confervoid Algæ), distinguished by the branched habit, and by the cells resembling bristles with a bulbous base situated at the tips of lateral shoots. They form villous tufts 1-4 to 1-2″ high on freshwater plants in lakes and pools.

The cells of the main filament multiply in the same way as those of ŒDOGONIUM, under which head the process is minutely described. The parent-cell breaks by a circumscissile dehiscence to allow the expansion of the two new cells. The bristles which are formed at the upper ends (alternately on each side of the filament, fig. 83) likewise break out from a slit in the cell from which they arise. The bristle is sometimes sessile on the cell from which it arises; sometimes multiplication takes place at its base, so that one or more cells are interposed; the bristle is always the oldest part of the branch.

Fig. 83.



Bulbochæte setigera.
Portion of a filament with a sporiferous cell.
Magnified 150 diameters.

These plants are multiplied by zoospores, and by resting-spores formed after fertilization by the contents of antheridial cells. The zoospores are formed from the whole contents of a globular or oval cell produced between the bristle-cell and the cell on which it is attached, which dehisces by a circular slit, causing the upper part with the bristle to separate, and allowing the single zoospore, crowned by a wreath of cilia (as in *Œdogonium*), to escape into the water, where it moves actively for a time, acquires a cellulose coat, and then germinates into a new filament. We have not space to give the details of the development of the parent-cell of the zoospore, which, however, are very interesting.

The resting-spores are formed, in the first place, somewhat in the same way and in the same situations as the zoospores; but the cell-contents do not escape. An orifice is formed in the wall of the parent-cell, through which the spermatozoids coming from the antheridia penetrate. The spore-mass then becomes encysted; and its contents are changed, the green colour arising from the presence of chlorophyll giving place to a brown tint. The resting-spore ultimately escapes by the rupture of the parent-cell (*oogonium*, Pringsheim); and in its germination (in the following season) the contents are developed into four zoospores, which escape from the spore-membrane and grow up singly into new plants (Pl. 5. fig. 22).

The history of the antheridia of the Œdogonieæ is somewhat complicated. In the present genus, a few short cylindrical cells are developed underneath the bristle-cell, either on special branches or on the sporangial branches, between the parent-cell of the spores and the bristle. These cells break by circumscissile dehiscence, and discharge their contents in a form exactly resembling the vegetative zoospores, but much smaller.

These ultimately come to rest, and commonly attach themselves to germinate upon the walls of the parent filament, often on the outside of the mother cell of the spore. When they germinate, they become short filaments composed of one, two, or several cells, in each of which is developed one or two spermatozoids, which are minute globular active bodies with a wreath of cilia, almost colourless, but in other respects resembling the much larger zoospores. These spermatozoids escape by the cells breaking across, and have been observed to enter the orifices in the walls of the parent-cells of the spores and effect the fertilization.

Pringsheim has described a number of species, characterized by the form of the sporange and the unicellular or multicellular condition of the antheridial plants, and by the relative dimensions of the organs. We are not assured of the value of these characters, and confine our list to one species.

B. setigera, Ag. (fig. 83), is a common plant, and is variable in the relative length and diameter of its cells, on which ground Kützing has separated a *B. minor*, where the diameter is equal to or greater than the length. Hassall, *Alg.* pl. 54. figs. 1–4; Dillwyn, *Confer.* pl. 59.

B. Pringsheimiana, Archer, *Qu. Mic. Jn.* 1866, p. 122.

Rabenhorst describes 16 species.

Bibl. Alex. Braun, *Verjüng.* (*Ray Soc.* 1853); Hassall, *Ann. N. H.* xi. 36; *Alg.* 209, pl. 54; Decaisne, *Ann. d. Sc. Nat.* 2 sér. xvii. 335, pl. 14. fig. 5; Kützing, *Sp. Alg.* 429; Pringsheim, *Berlin Ber.* 1855 (*Ann. N. H.* ser. 2. xv. 346; *Qu. Mic. Jn.* iv. 131, 1856); *Jahrb. f. wiss. Bot.* i. 11, 1857; De Bary, *Mus. Senckenberg*, 1856, 29; Rabenhorst, *Fl. Alg.* iii. p. 357; Sachs, *Bot.* 281.

BULBOTRICH'IA, K.—A doubtful genus of Algæ.

Char. Filaments indistinctly jointed, colourless, subcartilaginous, branched; branches bulbous at the base, tumid at the apex, forming sporangia.

B. botryoides. Forming a hoary-green powdery stratum; sporangia green. On roofs.

B. peruana. On rocks.

Bibl. Kützing, *Tab. Phyc.* iv. p. 22; Rabenhorst, *Fl. Alg.* iii. p. 374.

BULIMI'NA, D'Orb. — An important group of Foraminifera, so called from their Bulimine shape, due to an increasing and spiral series of one, two, and even three chambers, close-set, with their apertures towards the umbilical axis. The aperture is an infolded notch of the septal face, and usually oblique. The shell hyaline in the young state, coarser in the adult. Many fossil specimens are arenaceous; these come under *Ataxophragmium*, Reuss. The varieties are infinite, both recent and fossil, and the names numerous. The oldest is found in the Trias. *B. Preslii*, Reuss, is typical. *B. pupoides* (Pl. 23. fig. 46) is a common Atlantic form.

Bibl. D'Orb. *For. Fos. Vien.* 61; Williamson, *Br. For.* 61; Carpenter, *Introd. For.* 194.

BUNT.—A disease of Cereal Grasses, &c., depending on Fungi. See Blight, Tilletia.

BURSA'RIA, Ehr.—A genus of Infusoria, of the family Bursarina.

Ehrenberg described fourteen species. They are mostly found in stagnant fresh water; some in the intestines of the frog, *Nais*, &c.

B. vernalis (*Panophrys*, D., *Frontonia*, Cl. & L.) (Pl. 30. fig. 19). Body ovate-oblong, turgid, green, rounded at each end, somewhat narrowed posteriorly, the mouth placed behind the anterior third or fourth of the body; fresh wat.; length 1-130 to 1-110″.

B. ranarum (*Opalina ran.*) (Pl. 31. fig. 47). Body ovate, lenticular, compressed, large, white, the dorsal and ventral surfaces keeled, anterior part subacute, often truncate posteriorly, mouth inferior, near the anterior pointed end; length 1-210 to 1-70″. In the intestines of the frog.

B. entozoon, Ehr., which is found in the rectum of frogs, is *Balantidium entoz.* of Cl. and Lachm.

Cl. and Lachm. admit only 1 species:

B. decora. Body urn-shaped, with a long convolute nucleus, and very numerous contractile vesicles, scattered through the parenchyma. Berlin.

The species of *B.* (Ehr.) are referred to other genera.

Bibl. Ehrenb. *Inf.*; Duj. *Infus.*; Stein, *Infus. Entwickel.*; Clap. and Lachm. *Inf.* p. 251; Kent, *Inf.* p. 574.

BURSARI'NA, Duj.—A family of Infusoria.

Char. Body very contractile, of variable form, usually oval, ovoid, or oblong, ciliated all over; a large mouth with cirri forming a row or part of a spire.

Claparède and Lachman divide the family thus:—

STENTORINA (subfamily). A carapace, at least at one period of life; anus anterior.
Body not truncate in front.
Buccal spire borne on a narrow process ..... *Chætospira.*
Buccal spire borne on a broad bilobed membranous expansion ..... *Freia.*
Body truncated in front by a broad surface bearing the buccal cirri on its circumference ..... *Stentor.*

BURSARINA (subfamily) proper. No carapace; anus posterior.
Watch-glass organ absent.
No row of cirri within the buccal fossa.
Front not projecting.
Body truncated in front by an oblique surface with buccal cirri at its circumference ..... *Leucophrys.*
Body not truncate in front.
Anterior bundles of cirri absent from buccal fossa.
No cirri on the right side.
Body linear ..... *Spirostomum.*
Body not linear ..... *Plagiotoma.*
Bordered with cirri on the right side also.
Body elongate, of uniform breadth ..... *Kondylostoma.*
Body globular, narrowed in front ..... *Balantidium.*
Buccal fossa very large, with two anterior bundles of cilia distinct from the buccal cirri *Lembadium.*
Fore part projecting beyond the buccal fossa.
Fossa oblique ..... *Metopus.*
Fossa not oblique ..... *Frontonia.*
Buccal fossa funnel-shaped, with a row of strong cirri ..... *Bursaria.*
A watch-glass-shaped organ at the side of the mouth ..... *Ophryoglena.*

Kent's arrangement differs from this, and includes several new genera, 21 in all.

BIBL. Duj. *Infus.*; Cl. and Lachm. *Inf.* p. 211; Kent, *Inf.* p. 574.

BUS'KIA, Alder.—A genus of Ctenostomatous Polyzoa (Bryozoa).

B. nitens. On Hydroida, &c.

BIBL. Hincks, *Polyzoa*, p. 531.

BUTTER.—The detection of the adulteration of butter is rather a matter of chemistry than of microscopic investigation. But Michels points out that the spurious butter (oleo-margarine) exhibits numerous free stellate or feathery crystals, often also fragments of animal tissues; while true butter presents a uniform appearance of fatty globules, and is perfectly free from any crystalline forms except those of chloride of sodium or common salt. (Michels, *Amer. Jn. Micr.* 1878; *Jn. Mic. Soc.* 1878, i. p. 378.)

BUTTERFLIES. See LEPIDOPTERA.

BUXBAUMIA'CEÆ.—A family of operculated Acrocarpous Mosses, of very dwarf stemless habit, arising from a minute tuft of radical filaments (figs. 84, 86, &c.). The leaves are small and flat, composed of few minutish, hexagonal or polygonal parenchymatous cells, empty, destitute of chlorophyll (fig. 86). The capsule (fig. 87), seated on an elongated, thick, fleshy and very scabrous stalk, is more oblique than in any other Mosses, very ventricose on one side, obliquely erect on the other (dorsal) side, cup-shaped at the base, articulated on its stalk, fungoid in general habit, with an obtusely conical straight operculum, and a peristome (fig. 93). Inflorescence monœcious. Brit. genus:

BUXBAU'MIA, Hall.—A genus of Buxbaumiaceæ (Acrocarpous Mosses), represented in Britain by *B. aphylla*, a plant of remarkable character. The annulus, which persists after the operculum has fallen, resembles a third, outer circle of peristomal teeth (fig. 93); the real external peristome is closely applied upon the inner, which forms a truncated cone, slightly twisted when dry. When ripe, the wall of the oblique capsule (fig. 88) gives way at one side, falls off and exposes the spore-sac (fig. 89), which bursts to discharge the spores. The columella (fig. 94) is very large; and the operculum is attached to its summit. The antheridia are oval cellular bodies opening by the separa-

Buxbaumia aphylla.

Fig. 84. Fig. 85. Fig. 86.

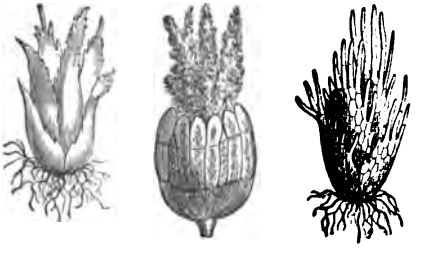


Fig. 84. A male antheridiiferous plant, magnified 40 diameters.

Fig. 85. An antheridium burst and discharging spermatozoids, magnified 100 diameters.

Figs. 86, 90, and 91. Archegoniiferous plant, in different stages, magnified 40 diameters.

tion of the cells like teeth above, to emit grumous masses of spermatozoids (fig. 85).

B. indusiata has been found at Aboyne, in Aberdeenshire, by Prof. Dickie.

Bibl. Bruch and Schimper, *Bryol. Europ.* part i.; Wilson, *Bry. Brit.* p. 198.

Buxbaumia aphylla.

Fig. 87. Fig. 88. Fig. 89.

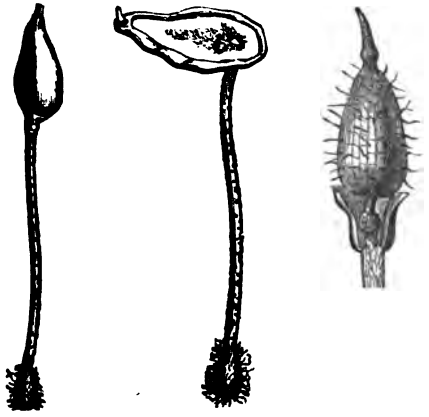


Fig. 87. A ripe capsule, magnified 15 diameters.
Fig. 88. A plant in which the capsule has burst and lost the spore-sac, &c., magnified 15 diameters.
Fig. 89. Spore-sac exposed by removal of the wall of the capsule, showing the filaments by which the spore-sac is suspended within the latter; magnified 40 diameters.

Buxbaumia aphylla.

Fig. 90. Fig. 91. Fig. 92.

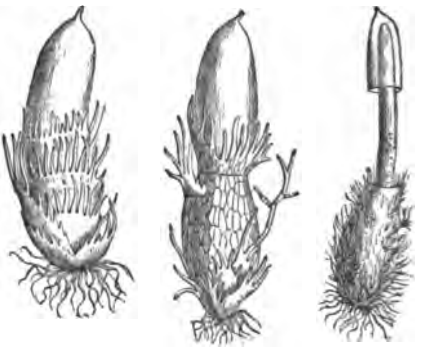


Fig. 92. A young fertile plant elevating its sporange covered by the calyptra, magnified 15 diameters.

Fig. 93. Fig. 94.

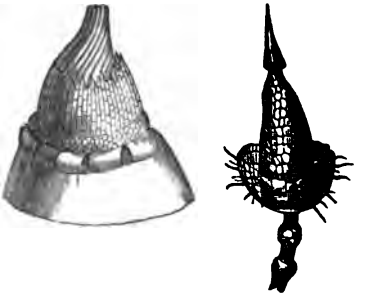


Fig. 93. Mouth of capsule, with double peristome and recurved persistent annulus; magnified 150 diameters.
Fig. 94. Columella with adherent operculum, both capsule-wall and spore-sac having been removed; magnified 60 diameters.

BYTHOCYTHE'RE, Sars.—A genus of Entomostraca (Ostracoda), fam. Cytheridæ.

Distinguished by the toothed mandibles, the 4-jointed lower, and the 7-jointed upper antennæ.

3 British living species: *B. simplex*, *B. constricta*, and *B. turgida*.

Bibl. Brady, *Linn. Tr.* xxvi. pp. 393, 450.

BYTHOTREPHES, Leydig.—A genus of Entomostraca, ord. Cladocera, fam. Daphniadæ. Allied to *Polyphemus* and *Evadne*.

B. longimanus. Caudal bristle two or three times the length of the body. Found in Scania.

Bibl. Leydig, *Daphnid.* 244; *Ann. N. H.* 1862, ix. p. 135.

C.

CABE'REA, Lamx.—A genus of Infundibulate Polyzoa (Bryozoa), of the suborder Cheilostomata, and family Cabereadæ.

Distinguished by the unjointed polypidom, with narrow branches; the cells in two or three rows, with large vibracula (whips) or sessile avicularia at the back, placed obliquely in two rows. Two British species.

C. Hookeri (*Cellularia Hook.*, Johnston). Cells rounded, diverging, and projecting. Rare.

Bibl. Johnston, *Br. Zooph.* 338; Busk, *Mar. Polyz.* 37; Hincks, *Polyzoa*, 57.

CABE'READÆ.—A family of Infundi-

bulate Polyzoa (Bryozoa), of the suborder Cheilostomata.

Distinguished by the unjointed polypidom, the narrow branches, the cells in two or more rows, with vibracula (whips) or sessile avicularia at the back. Genera:

Caberea. Back of branches covered with large vibracula.

Amastigia. Vibracula absent. Not British.

BIBL. Busk, (*Brit. Mus.*) *Catal. of Mar. Polyzoa*, 37; Johnston, *Brit. Zooph.*

CABINET for holding microscopic objects. See INTRODUCTION, p. xxiii.

CACTA'CEÆ.—A singular family of Dicotyledonous plants, especially remarkable, microscopically, for the peculiar structure of their wood-cells. See SPIRAL FIBROUS STRUCTURE, and WOOD.

BIBL. Schleiden, *Anat. der Cacteen*, 184; Miquel, *Ann. d. Sc. Nat.* 2 sér. xix. 165.

CA'DIUM, Bail.—A genus of Rhizopoda, fam. Actinophryina ?. Animal unknown.

Char. Shell siliceous (?), ovoid, with a bent beak, and a circular aperture; often with a long curved tapering appendage at the base, and with numerous meridian lines, of which about twelve are visible at once.

C. marinum (Pl. 51. fig. 30). Soundings in the sea of Kamtschatka, and the Gulf-stream.

BIBL. Bailey, *Silliman's J.* 1856, xxii. p. 3, pl. 1. f. 2; Wallich, *M. M. J.* i. p. 107, pl. 3.

CAD'MIUM.—Solution of the oxide or carbonate of this metal in sulphuric acid, when evaporated on a slide, yields disks or circular aggregations of minute radiating needles (circular crystals) of the sulphate, which exhibit essentially the same phenomena under the action of polarized light as those of the oxalurate of ammonia. The disks frequently exhibit irregular undulating, somewhat concentric dark bands, indicating parts where no double refraction takes place.

Pl. 39. fig. 10 gives but a very imperfect idea of the appearances presented by these crystals when viewed by polarized light.

CÆOMA'CEI. See UREDINEI and USTILAGINEI.

CALA'NUS, Leach, = TEMORA.

CALCARI'NA, D'Orb.—One of the Rotaline Foraminifera; asymmetrically helicoid, with three or more whorls or chambers; coated with exogenous shell-growth, as granules, spines, and stick-like processes. Shell thick, with the vascular and supplementary skeleton. Common in the Chalk of Maestricht, and in several Tertiary strata; and living abundantly in the Mediterranean and other warm seas.

C. Spengleri (Pl. 24. fig. 27).

BIBL. Reuss, *Sitz. Ak. Wiss. Wien*, xliv. 315, 1861; Carpenter, *Foram.* 1862, 216, &c.

CALCIUM, CHLORIDE OF.—This salt may be prepared by adding excess of prepared chalk to dilute muriatic acid, boiling and filtering the solution, and then evaporating it to dryness. The crystals belong to the rhombohedric system, and are deliquescent.

An aqueous solution of chloride of calcium is of great service in microscopic researches, as objects which have been immersed in or moistened with it do not become dry at ordinary temperatures. Hence, if a drop of the solution be added to an object covered with thin glass, and excluded from dust, it may be preserved without the use of a cement to enclose it in a cell (see PRESERVATION). Its use in determining the presence of cell-membranes has been already alluded to (INTRODUCTION, p. xli, § 4). When employed for this purpose, its action must always be controlled by the action of water, crushing, &c.

The strength of the solution may be about one part of salt to two of water, or a saturated solution may be used; it should be kept in one of the test-bottles (INTROD. p. xxvii), with a lump of camphor floating on its surface.

It frequently happens that the solution in which objects have been immersed (on a slide) exhibits crystals. These usually consist of either the chloride itself, the sulphate or the phosphate of lime, the two latter formed from the alkaline salts derived from the object.

CALCULI. See CONCRETIONS.

CALEP'TERYX, Linn.—A genus of Neuropterous Insects, belonging to the family LIBELLULIDÆ.

CALIA, Werneck.—A doubtful genus of Infusoria.

Char. Monads included in jelly (*Pandorinæ*) fixed to aquatic plants, not swimming free. Two species.

BIBL. Werneck, *Ber. de Berl. Ak.* 1841, 377.

CALI'CIUM, Ach.—A genus of Lichenaceous Lichens, tribe Caliciei.

Char. Thallus granular, powdery, squamulose or evanescent. Apothecia black, sti-

pitate or subsessile; spores brown or black. Spermatia short, oblong.

Eighteen British species. *C. hyperellum*: on oak, lime, &c. Very common.

BIBL. Leighton, *Lich.-Fl.* 1879, 39; Tulasne, *Ann. d. Sc. N.* 3 sér. xvii. 209.

CALIG'ONUS, Koch.—A genus of Acarina, fam. Trombidina. Has the legs 7-jointed, and a line between cephalothorax and abdomen.

C. niger. Not described by Koch, but figured; very minute.

BIBL. Koch, *Uebers.*; Murray, *Ec. Ent.* 124.

CA'LIGUS, Müller.—A genus of Crustacea, of the order Siphonostoma, and family Caliginea (*Caligidæ*).

Char. Head in the form of a large buckler, having anteriorly large frontal plates, which are furnished with a small suctorial disk or lunule on the under surface of each lateral portion; antennæ small, flat and two-jointed. Thorax with only two distinct articulations, thoracic segments uncovered; second pair of jaw-feet two-jointed and not in the form of a suctorial disk. Legs, four pairs with long plumose hairs, fourth pair slender, of only one branch and serving for walking.

Four species. Found upon the brill, cod, mackerel, plaice, trout, &c.; length 1-5 to 1".

BIBL. Baird, *Brit. Entom.* pp. 256, 269.

CALLIDI'NA, Ehr.—A genus of Rotatoria, of the family Philodinæa.

Char. Eye-spots absent; a proboscis and a foot with horn-like processes.

The rotatory organ is double, but not furnished with a stalk; proboscis also ciliated; foot elongate, forked, and with four accessory horn-like processes, hence with six points altogether; teeth small and numerous (two only in each jaw in one species, Gosse). Fresh water.

C. elegans, Ehr. (Pl. 43. fig. 10). Crystalline; length 1-70". (Pl. 43. fig. 11, jaws.)

C. rediviva, Ehr. Granular or fleshy, ova red; length 1-70".

C. bidens, Gosse. Teeth two in each jaw; length 1-45".

C. constricta, Duj. Rotatory organ constricted; length 1-50".

C. parasitica, Gig. On *Gammarus* and *Asellus*.

BIBL. Ehrenb. *Inf.* p. 482; Dujardin, *Inf.* p. 655; Pritchard, *Inf.* p. 701; Gosse, *Ann. N. H.* 1851, viii. p. 202; Giglioli, *Qu. Mic. J.* 1863, p. 237.

CALLITHAM'NION, Lyngb.—A genus of Ceramiaceæ (Florideous Algæ), containing a large number of species, some common, many rare. In the smaller species the structure is very simple, the branched feathery fronds being composed of single rows of tubular cells; in the larger species the stem and larger branches are strengthened by external filaments, which grow over the original axis, apparently originating at the base of the upper branches and growing down (somewhat as in *Batrachospermum*). Antheridia have been observed in *C. Borreri* and *C. corymbosum*, collected in tufts on the ultimate branches. The *favellæ* are naked, and the tetraspores are tetrahedrally arranged.

BIBL. Harvey, *Mar. Algæ*, pl. 23 A; *Phyc. Br.* pls. 129, 272, 230, &c.; Thuret, *Ann. d. Sc. N.* 3 sér. xvi. p. 16, pl. 4; Nägeli, *Algen-Systeme*, 198, pl. 6.

CALLODIC'TYON, Carter.—A genus of Rhizopoda (Flagellate Infusoria, Kent).

Char. Naked, free, ovate or variable, highly vacuolar; flagella three, food admitted by the surface.

C. triciliatum. Length $\frac{1}{770}$". Fresh water, Bombay.

BIBL. Carter, *Ann. N. H.* 1865; Kent, *Inf.* 307.

CALO'CERA.—A genus of Clavariei (Hymenomycetous Fungi) differing from Clavaria in the subcartilaginous texture and viscid hymenium; the structure moreover approaches that of Tremellini. *C. viscosa*, which occurs on decayed pine-stumps, is one of our most beautiful Fungi. Three or four more species occur in this country.

BIBL. Berk. *Outl.* p. 284.

CALODIS'CUS, Rabenhorst, = *Campylodiscus*.

CA'LOTHRIX, Ag.—A genus of Oscillatorieæ (Confervoid Algæ), growing in tufts, the filaments forming a branched frond by lying in apposition and being concreted by their sheaths here and there. *C. mirabilis*, Ag. (Pl. 8. fig. 22), is a rare freshwater species in England, found on mosses in small streams, æruginous green, growing blackish. Diameter of the filaments about 1-1200 to 1-1800". According to Hassall, *C. atrovirdis*, Harv., is not distinct.

Other species.

Fig. 95 illustrates the close annulations on the filaments of this genus; the nature of which will be treated more particularly under the head of OSCILLATORIACEÆ.

Bibl. Hassall, *Algæ*, 243, pl. 69. 1; Kützing, *Tab. Phyc.* cent. ii. pl. 29. ii.; Dillwyn, *Br. Confervæ* (*C. mirabilis*), pl. 96; Rabenhorst, *Sp. Alg.* ii. 270; Bornet & Thuret, *Notes Algol.*

CALYCEL'LA, Hincks.—A genus of marine Zoophytes, of the order Hydroida, and family Lafoëidæ.

Char. Stem creeping, simple; or erect, compound and branched; cells tubular, with an operculum formed of convergent segments or a plaited membrane; polypes cylindrical, with a conical proboscis.

C. syringa = *Campanularia syr.* Very common on sea-weeds, &c.

C. fastigiata.

Bibl. Hincks, *Brit. Zooph.* p. 205.

Fig. 95.

Calothrix Tomasiniana. Fragment of a filament. Magnified 300 diams.

CALYMPERACEÆ.—A tribe of Pottioid Mosses, containing one British genus:

Encalypta. Calyptra long, cylindrically bell-shaped, narrow above on account of the clavellate operculum, surpassing the capsule, firm, entire, torn or ciliated below (fig. 97). Peristome absent, simple (fig. 96), or double (fig. 98). External: sixteen lanceolate or long-subulate, ciliiform teeth, mostly with a longitudinal line, reddish, rugulose. Internal: a delicate membrane adherent to the teeth, produced into cilia opposite or alternating with the teeth.

Fig. 96.

Fig. 98.

Fig. 97.

Fig. 96. Encalypta vulgaris. Peristome.
Fig. 97. E. ciliata. Calyptra.
Fig. 98. E. streptocarpa. Fragment of peristome.

CALYPOGE'IA, Raddi.—A genus of Jungermannieæ (Hepaticæ), founded on *Jungermannia Trichomanis*, Dicks. The leaves have a peculiar glaucous hue; the sporange is spirally twisted. Gemmæ are produced at the extremities of leafless prolongations of the stem.

Bibl. Hooker, *Brit. Jungerman.* pl. 79; *Eng. Botany*, 1728.

CALYPTOS'TOMA, Cambridge.—A genus of Acarina, fam. Trombidina.

C. Hardii. Reddish-yellow, punctate; eyes 6, in 3 pairs, forming a triangle.

Among moss; Cheviot Hills.

Bibl. Cambridge, *Ann. N. Hist.* 1875, xvi. 384 (fig.); Murray, *Ec. Entom.* 140.

CAM'BIUM.—The name applied to the young cellular layers from which the woody structures of plants are developed. When sections are made near the growing points of any stems, as in terminal or axillary buds, we find a quantity of extremely delicate, slender, elongated cells, distinguished from the generally rounded cells of the parenchyma, and forming rudimentary cords in the situation of the future woody and vascular bundles. In the Dicotyledons, they stand in a circle, so as to separate the pith from the young bark; the ring may be seen in cross sections a little below the growing-point. At the very apex of the stem all the tissues merge into the delicate universal generative tissue or meristem. In the apex of Monocotyledonous stems, and also those of Ferns and the higher Flowerless plants, the cambium is found in delicate cords imbedded in the nascent general parenchyma, indicating, even in this early condition, the position and arrangement of the isolated fibrous and vascular bundles. Sections of the outer region of the stem of Dicotyledons demonstrate the existence of a layer of cambium at the outer surface of the youngest wood, which indeed passes gradually into the cambium (figs. 792, 808). This cambium is the tissue from which the succeeding layers of wood are generated; and its position on the outside of the fibro-vascular bundles gives these their indefinite power of development. The cambium of the Monocotyledonous bundles becomes in-

closed between the wood and vessels of individual bundles, so that their growth is limited. The cambium of the outside of the wood of Dicotyledons forms new layers of liber, in most cases, on the inside of the old ones, *pari passu* with the development of the layers of wood. Cambium, which is in great part only an early and transitional form of cellular tissue, afterwards to become developed into wood, is composed of delicate cellulose cells enclosing a primordial utricle, nucleus, and abundance of nitrogenous protoplasm, but usually without chlorophyll. The cells multiply by transverse division in the elongation of the stem, and by perpendicular division (tangential and radial) as the stem expands in diameter. This process is effected by the constriction of the primordial utricle and gradual development of a septum, as in ordinary vegetative cell-development. The cambium of most Dicotyledons is gradually matured into wood from within outwards; but in the Monocotyledons and Flowerless Cormophytes it often remains in great part in a delicate and soft condition, forming the *vasa propria* of Mohl. Owing to the delicacy of its structure, cambium was formerly imagined to be a thick mucilaginous fluid poured out in the growing regions of plants (as between the wood and liber of Dicotyledonous stems in spring); which by degrees becomes organized and converted into cellular tissue, by the independent origin and subsequent coalescence of a number of cells generated in this fluid. This erroneous view was strongly supported by Mirbel and others.

Bibl. Treviranus, *Phys. d. Gewächse*, i. 159; Mirbel, *Ann. d. Sc. N.* 2 sér. xi. 321, xix. 197; Payen, *Compt. Rend.* 1839; Schleiden, *Botanik*; Henfrey-Masters, *Botany*; Nägeli, *Zeitsch. f. wiss. Bot.* iii. 64, & *Mikr.* 576; Mohl, *Vegetab. Zelle* (Transl.); Schacht, *Pflanzenzelle*; Sachs, *Bot.* 83.

CAMBRIC.—This name was formerly applied strictly to the finest kind of *linen* cloth. It is used now in a loose sense in trade. French cambric, however, ought to be linen. Scotch and English cambrics are commonly made of cotton, while Indian cambric is made of the grass-cloth fibre. The fibres may be distinguished under the microscope, and the value of the fabric thus ascertained. See Fibrous Substances and Cotton.

CAMERA LUCIDA. Introduction, p. xxii.

CAMPANULA'RIA, Lamk.—A genus of Hydroid Zoophytes; family Campanulariidæ.

Distinguished by the creeping or erect polypidom, the filiform continuous main tube, giving off its stalked and campanulate cells irregularly or in whorls, the usually long, ringed stalks, and the scattered, sessile vesicles.

Hincks defines the genus thus:—Stems simple or branched; cells bell-shaped and hyaline, without operculum; polypes with a large cup-shaped proboscis; germ-cells borne on the stems or the creeping stolon, with fixed spore-sacs. 13 species; 3 doubtful.

C. volubilis (Pl. 41. fig. 4). Stem a single tube, creeping, filiform; cells on long, slender ringed stalks, campanulate, with a serrated margin; vesicles ovate, wrinkled concentrically. Parasitic on sea-weeds &c.; frequent. It forms an elegant microscopic object.

C. dumosa. Stem compound, erect or climbing, irregularly branched; cells long, tubular, patent, almost sessile, orifice entire. In deep water.

Bibl. Johnston, *Brit. Zooph.* 107; Gosse, *Mar. Zool.* i. 24; Hincks, *Brit. Zooph.* 160.

CAMPANULARI'IDÆ, Johnston.—A family of marine Hydroid Zoophytes.

Char. Those of Sertulariidæ, but cells stalked.

Genera: *Campanularia, Laomedia.*

Hincks revises the family thus: Cells terminal, stalked, campanulate; polypes with a large trumpet-shaped proboscis. And admits the genera *Clytia, Obelia, Campanularia, Lovenella, Thaumantias,* and *Gonothyræa.*

Bibl. Johnston, *Brit. Zooph.*; Gosse, *Mar. Zool.* i.; Hincks, *Br. Zooph.* p. 137.

CAMPANULI'NA, Van Beneden.—A genus of marine Hydroid Zoophytes; family Campanulinidæ.

Char. Stem simple or branched, rooted; cells pointed above; polypes cylindrical, with webbed tentacles; reproduction by free medusa-buds, single in each capsule. 3 species.

Bibl. Hincks, *Brit. Zooph.* p. 186.

CAMPANULI'NIDÆ.—A family of Polypi, order Hydroida.

Char. Cells ovato-conic, stalked; polypes long, cylindrical, with a small conical proboscis.

Genera: *Campanulina, Zygodactyla, Opercularella.*

CAMPTOCER'CUS, Baird (*Lynceus*

Müll. pt.). A genus of Entomostraca, order Cladocera, family Lynceidæ.

Char. Carapace ovoid; beak blunt, directed forwards or slightly downwards; abdomen long, slender, tail-like, extremely flexible, and serrated. 1 species:

C. macrourus (Pl. 20. fig. 4). Carapace striated longitudinally, slightly sinuated and ciliated on the anterior margin; beak rather blunt; aquatic.

Bibl. Baird, *Brit. Entom.* p. 128.

CAMPTOSU'RUS, Presl, = *Scolopendrium*, pt.

CAMPTOTHE'CIUM, Br. & Sch. = *Hypnum* in part.

CAMP'TOUM, Link.—A genus of Dematiei (Hyphomycetous Fungi), allied to *Arthrinium*. *C. curvatum*, Lk. (*Arthrinium curvatum*, Kze.) grows in tufts of very slender filaments, bearing very minute, curved spores, upon *Scirpus sylvaticus*.

Bibl. Berk. and Br. *Ann. N. H.* 2 ser. viii. 100; Fries, *Syst. Myc.* iii. 377; Corda, *Ic. Fung.* iii. pl. 1. fig. 17.

CAMPYLODIS'CUS, Ehr.—A genus of Diatomaceæ.

Char. Frustules single, free, disk-shaped; disk curved or twisted (saddle-shaped); furnished with mostly radiate markings, which are frequently interrupted. Aquatic and marine.

The markings are costæ or canaliculi, forming minute canals between the internal cell-membrane and the surrounding fluid (Smith).

Smith describes 9 species (British); Rabenhorst describes 28 European species, and enumerates 27 foreign and fossil species.

C. costatus, Smith (Pl. 16. fig. 16). Valves circular; radii 30–40, extending about halfway to the centre, which is minutely punctate; diameter 1-270″; aquatic.

C. spiralis, Smith. Outline of front view resembling a figure of 8; valves elliptical; radii about 60, nearly parallel and transverse; length 1-160″; aquatic.

C. clypeus, Ehr. (Pl. 25. fig. 18). Valves suborbicular, exhibiting a circular and a median transverse hyaline line; radii broad, interrupted in the middle, which is punctate; length 1-200″; aquatic and fossil.

Bibl. Smith, *Br. Diat.*; Kützing, *Bacill.* and *Sp. Alg.*; Rabenhorst, *Fl. Alg.* i. 45; Grun, *Wien. Verh.* 1862; Schmidt, *Atlas Diatom.*

CAMPYLONE'IS, Grun.—A genus of Diatomaceæ, family Entopyleæ.

Char. Frustules scutelliform, adnate, transversely arcuate; valves heterogeneous—the inferior costate, the superior cribroso-punctate; nodules absent.

C. Argus. Atlantic.

Bibl. Grun, *Wien. Verhandl.* 1862, 429.

CAM'PYLOPUS, Brid. (Musci) = Dicranum.

Bibl. Wilson, *Bryol. Brit.* p. 87.

CAM'PYLOPUS, Cl. and Lachm.—A genus of marine Infusoria, family Oxytrichina.

C. paradoxus (Pl. 51. fig. 29). With six posterior setæ, and eight posterior feet, six on the right and two on the left side. Remarkable for its bounding leaps, which make it very difficult of observation.

Bibl. Claparède and Lachmann, *Infus.* p. 184.

CAMPYLOSTE'LIUM, Br. and Sch.—A genus of Leptotrichaceous Mosses, including some *Dicrana* and *Grimmiæ* of older authors.

Bibl. Wilson, *Bryol. Brit.* p. 51.

CAMPYLOSTYLUS, Shadb.—A genus of Diatomaceæ: = *Synedra*, sp.

Bibl. Greville, *Qu. Mic. J.* 1862, 232.

CANADA BALSAM. See Balsam.

CANALICULI. See Bone.

CANCER. See Tumours.

CANCROID. See Tumours, Cancroid.

CANDA, Lamx. (*Cellularia* part, Johnston).—A genus of Infundibulate Polyzoa (Bryozoa), of the suborder Cyclostomata, and family Cellulariidæ.

Distinguished by the jointed, branched, erect polypidom, the flat, linear branches with the cells on one plane, and the cells having a vibraculum in a notch on the outer side but no avicularium at the upper angle.

Placed with *Scrupocellaria* by Hincks.

C. reptans (*Cellularia rept.*, Johnston) (Pl. 41. figs. 5, 5 *c*, and 5 *d*). Orifice oval, with 3 or 4 marginal spines, and a stalked operculum with a lobed lamina. Common.

Bibl. Johnston, *Brit. Zooph*; Busk (*Brit. Mus.*) *Polyzoa*, 26; Hincks, *Polyzoa*, 43.

CANDA'CE, Dana.—A genus of Entomostraca (Copepoda).

G. pectinata. Dredged at Scilly.

Bibl. Brady, *Copepoda* (Ray Soc.), i. 48.

CANDEI'NA, D'Orb.—A modification of the Globigerine type of *Foraminifera* (according to Brady), built up with a three-sided alternation, and having a row of pseudopodial pores along the base of its last chamber.

Bibl. D'Orbigny, *For. Foss. Vien.* 193; Brady, *Qu. Mic. Jn.* 1879, xix. 78.

CANDO'NA, Baird (*Cypris* in part, Müll.).

—A genus of Ostracoda (Entomostraca), family Cypridæ.

Char. Two pairs of antennæ; superior long, with numerous joints and a pencil of long filaments; inferior stout and pediform, without a tuft of long hairs or filaments (see CYPRIS); eye single; motion creeping only. Five British species; freshw.

C. albicans, Br.; *lactea*, Bd.; *compressa*, Koch; *candida*, Müll.

BIBL. Baird, *Entom.* 159; Norman, *Ann. N. H.* 1862, ix. 46; Brady, *Linn. Tr.* 1868, xxvi. 381.

CANNA.—A genus of Monocotyledonous plants belonging to the same natural family as the arrow-root (Marantaceæ), and valuable from the same cause. *Tous-les-mois* is a starch derived from the tubers of a *Canna*, supposed to be *C. edulis*, Ker. The grains of genuine *Tous-les-mois* have distinctive microscopic characters, as shown in Pl. 46. fig. 25.

CANTHAREL'LUS.—A genus of Agaricini (Hymenomycetous Fungi), differing from *Agaricus* in the vein-like gills.

CANTHOCAMPTUS, Baird (*Cyclops*, pt., Müll.).—A genus of Entomostraca, of the order Copepoda, and family Cyclopidæ.

Char. Jaw-feet small, simple; inferior antennæ simple; ovary single.

Four species; one aquatic, three marine.

C. minutus (Pl. 20. fig. 6). Thorax and abdomen not distinctly separate, consisting of ten segments, successively diminishing in size, the last terminating in two short lobes, from which issue two long filaments, slightly serrate on their edges; antennæ short, seven-jointed in the male, nine in the female; inferior antennæ simple, two-jointed, the first joint with a small lateral joint, terminated by four setæ; feet five pairs.

Common in ditches; colour reddish, length about 1-15". (Pl. 20. fig. 6: *a*, inferior antenna; *b*, first pair of jaw-feet; *c*, second pair.)

C. cryptorum, Brady. In a coal-mine.

BIBL. Baird, *Brit. Entom.*; Brady, *Qu. M. Jn.* 1869, p. 23.

CAOUTCHOUC.—A gum-resinous substance contained in the milky juices of many plants, but most abundantly in those of the families Euphorbiaceæ, Urticaceæ and Apocynaceæ, whence the India-rubber of commence is obtained. The caoutchouc appears in the form of minute globules suspended in a watery fluid containing a gummy substance; so that the milky juice may be regarded as a kind of emulsion. See LATEX.

CAPILLARIES.—The minute intermediate vessels which the blood traverses in passing from the arteries to the veins.

The capillaries appear to consist of a delicate, transparent, tolerably resisting and elastic membrane, and a number of oval or rounded longitudinal nuclei; but when treated with very dilute solution of nitrate of silver, the dark dyed outlines of the epithelial cells, to which the nuclei belong, are brought to light (Pl. 51. fig. 31). The diameter of the human capillaries varies from 1-5000 to 1-1000", the most common being perhaps 1-3000". The size of the capillaries in the Vertebrata generally, bears a relation to the size of the coloured corpuscles of the

Fig. 99.

Magnified 300 diameters.

One of the smallest vessels from the arterial side. 1, smallest artery; 2, transition vessel; 3, large capillaries; 4, small capillary. *a*, structureless membrane with few nuclei, representing the adventitious coat; *b*, nuclei of the muscular fibre-cells; *c*, nucleus inside the small artery; *d*, nuclei of the capillaries and intermediate vessel. From the human brain.

blood; and thus they are largest in Birds, Fishes, and Reptiles. The larger capillaries

have thicker walls and more numerous cells than the smaller ones.

The capillaries branch and anastomose freely, giving rise to the beautiful networks so well known as favourite microscopic objects when injected.

The most important pathological changes which the capillaries undergo are those of the FATTY and AMYLOID DEGENERATION. The general arrangement of the capillaries is best seen in injected preparations (INJECTION). Their structure may be examined in pieces of the pia mater, of the retina, or the mesentery of an animal: a minute portion of washed lung will also answer the purpose well. These should be dissected with the mounted needles. The relation of the capillaries to the surrounding minute structures may be shown in portions of tissue which have been imperfectly injected, or injected with a liquid containing a small quantity only of opaque colouring-matter; in these the capillaries may be recognized by their containing the scattered granules of the colouring-matter. Between the cells are certain spaces (stomata), best seen in silvered preparations. In the spleen-pulp, and in the tissues of many of the lower animals, the finest currents of blood pass through lacunæ or wall-less channels.

The capillaries are developed from branched connective corpuscles. Non-medullated nerves have been traced into the walls of the capillaries.

Acetic acid is frequently of use in rendering the tissues transparent, and bringing the nuclei to light. The finer capillaries are made more distinct by dyeing with carmine or logwood.

BIBL. Kölliker, *Mikr. An.* Bd. ii.; Henle, *Allg. Anat.*; Frey, *Histologie* (full Bibliography); Schmidt, *Mn. Mic. Jn.* xiii. 1 (figs.); Eberth, *Stricker's Handbuch*; Chrzonszczewsky, *Virchow's Archiv*, XXXV. 169; Cornil & Ranvier, *Hist. path.*; Rindfleisch, *Hist.*; and the BIBL. of TISSUES.

CAPNODIUM, Montagne.—A genus of Perisporiacei (Ascomycetous Fungi) growing as a kind of mildew on leaves and shoots, forming a blackish flocculent coat composed of short, branched, beaded or moniliform filaments, densely interwoven. The perithecia arise vertically from this, and are either simple or branched, at first simple sacs, but probably afterwards thickened by a layer of cells; a number of threads ultimately grow up from the mycelium, partially cover the central sac; and, closely crowded, some of their tips project beyond it, forming a fringe; the cells of this fringe readily become detached and appear to reproduce as *conidia*. The central sac contains largish delicate asci, probably often absorbed at an early period, so as to set the spores free in the cavity.

Particular joints of the filaments sometimes become *pycnidia*, producing free spores in their interior, without asci.

Several species seem to occur in Britain; and amongst them *C. elongatum*, Berk. & Desm. On pear-leaves.

C. (*Fumago*) *quercinum*, Pers., grows on oak-leaves.

C. (*Fumago*) *Footii*, Berk. & Desm., on evergreens, on the birch-tree, and on *Mercurialis perennis*.

BIBL. Berkeley, *Crypt. Bot.* p. 275; Berk. & Broome, *Ann. N. H.* 2nd ser. xiii. p. 408; Berk. & Desmazières, *J. Hort. Soc.* iv. 243; Montagne, *Ann. N. H.* 2nd ser. iii. p. 520.

CAPSOSI'RA, K.—A genus of Rivularieæ.

Char. Filaments erect, narrow, crowded, parallel, moniliform, sheathed; cells thick-walled.

C. Brebissonii (Pl. 53. fig. 11.). Greenish black. On stones, in streams (France).

BIBL. Kützing, *Sp. Alg.* 344; Rabenhorst, *Fl. Alg.* ii. 223.

CARAPACE, or LORICA.—A term somewhat indefinitely applied to the whole or a part of the shell or outer coat of certain animals—as those belonging to the classes Crustacea, Rotatoria, Infusoria, &c.

In regard to the Rotatoria and Infusoria, it has been divided into:—the *testa* or *testula*, an envelope resembling that of the tortoise, within which the body of the animal is enclosed, the head and the tail being free—as in the genera *Brachionus*, *Monura*, *Colurus*, &c.; the *scutellum*, a round or oval envelope, covering only the back of the animal, in the manner of a buckler; and the *urceolus*, a membranous or firm envelope, sometimes gelatinous, in the form of a bell or cylinder, open at one end and closed at the other, and within which the animal can completely retract itself—as in DIFFLUGIA &c.

Ehrenberg extended the use of this term also to the external envelope of *Volvox*, *Gonium*, and the Diatomaceæ. As these have been removed to the vegetable kingdom, it is not now applied to them.

CARBA'SEA, Gray.—A genus of Infundibulate Polyzoa, of the suborder Cheilostomata, and family Flustridæ (*Flustra*, pt., Hincks).

Distinguished by the expanded, leafy, flexible, erect polypidoms; and the cells being arranged in many rows, on one side only.

C. papyrea (*Flustra carbasea*, Johnst.) (Pl. 41. figs. 19, 20). Cells oblong, narrowed and truncate below, convex, unarmed. Deep waters.

Bibl. Johnston, *Br. Zooph.* 345; Busk, *Mar. Polyzoa*, 50; Hincks, *Polyz.* 123.

CARBOLIC ACID or Phenole.—This substance is largely used as a germicide and antiseptic, and is very valuable in the preservation of animal and vegetable structures. The pure crystallized acid should be procured. See Preservation.

CARBONATE OF LIME. See Lime, Carbonate of.

CARBO'NIA, Jones.—A genus of small Cypridiform *Entomostraca*, found in the Carboniferous strata, and distinguished chiefly by their peculiar muscle-spot.

Bibl. T. R. Jones, *Geol. Mag.* iii. 218, pl. 9, f. 4–10; Jones & Kirby, *Ann. N. H.* 1879, iv. 28.

CARBONIC ACID.—The presence of this gaseous acid is usually determined by the addition of another acid, as acetic or muriatic, to the object under the microscope; and if colourless and inodorous bubbles escape, it is concluded, and in most cases correctly, that carbonic acid is present.

It must be borne in mind that if the object be immersed in liquid, the gas may arise either from this or the object; for it is well known that the escape of a gas from a liquid charged with it is greatly facilitated by the presence of a solid and especially a pointed body, and that the gas escapes from the liquid at its surface or point; thus the false appearance is produced of the gas being liberated from the body. Hence the importance of washing the object before the addition of the acid.

When crystalline bodies of different forms are present, these must be separated before the addition of the acid; otherwise the bubbles liberated from those of one kind, by escaping at the surface of the others, may give rise to the false conclusion that they were derived from the latter.

Recollection of the fact that carbonic acid is readily absorbed by solution of potash, would allow of the distinction of bubbles of this acid from those of air.

CARCHE'SIUM, Ehr.—A genus of Infusoria, belonging to the family Vorticellina.

Char. Pedicle branched, spirally flexible; bodies of the animals all alike (= branched *Vorticellæ*).

C. polypinum (Pl. 30. figs. 20, 21). Campanulate, expanded in front; cuticle smooth; nucleus recurved in a longitudinal plane; peduncle not jointed; length of bodies 1-580–1-430"; freshw.

C. spectabile. Thimble-shaped, not expanded; cuticle finely striated; nucleus recurved in a longitudinal plane, with several sinuosities; peduncle not jointed; freshw., fœtid.

C. Epistylis. Body very narrow, smooth; nucleus curved in a transverse plane; peduncle distinctly jointed; freshw., in insect-larvæ.

Bibl. Ehrenb. *Inf.* and *Ber. d. Berl. Ak.* 1840, 199; Dujardin, *Inf.* 551; Stein, *Infus.* 48, &c.; Clap. and Lachm. *Inf.* 97; Kent, *Infusoria*, 690.

CA'RIS, Latreille.—A doubtful genus of Acarina.

C. vespertilionis is found upon the bat (*Vespertilio pipistrellus*), supposed to be the larva of *Dermanyssus*, or *Argas*.

Bibl. Latreille, *Gen. Crustac. &c.* i. 161; Audouin, *Ann. d. Sc. N. Zool.* xxv. 412; Walckenaer, *Aptères* (*Gervais*), 227.

CARMINE.—This beautiful pigment is sometimes used to feed Infusoria and fill their sacculi or gastric spaces (Infusoria).

It is also used as a colouring-matter for injections and for dyeing or staining tissues (see Staining).

CAR'PAIS. See Gamasus.

CARPENTE'RIA, Gray.—A genus of Foraminifera allied to *Globigerina*, but ceasing at an early age to grow spirally, and then forming expanded tent-like chambers which enclose the first-formed cells; attached by the base to shells or corals, and with a crater-like common aperture at the apex. Siliceous spicules occur in the cells.

C. balaniformis. (Pl. 51. fig. 28.)

Bibl. Carpenter, *Introd. Foram.* 186.

CARPOGLY'PHUS, Robin, = *Acarus* sp. (p. 5).

CAR'POGON, the name applied by Sachs to the fruit or sporocarp of his Class Carposporeæ. See Vegetable Kingdom.

CARPOMITRA, Kütz.—A genus of Sporochnaceæ (Fucoid Algæ) containing one rare British species, *C. Cabreræ*, Clem., remarkable for the peculiar mitre-shaped conceptacle containing the spores.

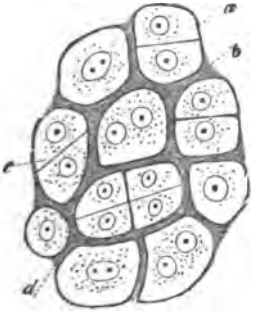
Bibl. Harvey, *Marine Alg.* pl. 5 B, *Phyc. Brit.* pl. 14.

CARTILAGE.—Cartilage consists of a firm, but elastic, bluish, milky or yellowish substance, which morphologically forms either a simple parenchyma composed of cells, or a structure consisting of cells immersed in an intermediate basis.

The cells of cartilage are usually round, oval, elongated or angular, frequently flattened and sometimes spindle-shaped. In some cartilage they appear stellate, or exhibit distinct radiating processes, as in that of the cuttle-fish, the sharks and rays, and enchondromatous growths.

In the ossifying pseudo-cartilage of true bone, real stellate cells are however met with. See BONE.

Fig. 100.



Magnified 350 diameters.

Primary (parent-) cells with one and two nuclei, or two and four secondary cells and intervening basis. From the cranial cartilage of a full-grown tadpole.

The cell-walls are generally thick, and frequently composed of several layers or capsules. The contents consist of a clear liquid and a nucleus; sometimes the cell and sometimes both the cell and the nucleus contain one or more globules of oil. The cells also frequently constitute parent-cells, *i. e.* cells containing other or secondary cells within them, these containing also nuclei or tertiary cells.

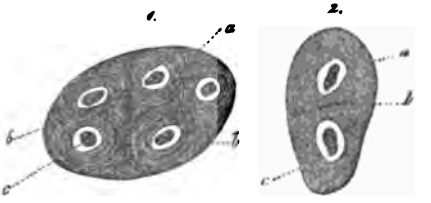
The secondary and tertiary cells sometimes exhibit well the internal layers.

It is undecided whether these capsular layers are hardened products of secretion of the cells, or whether they represent the changed peripheral portions of the cell-bodies themselves. The latter seems most probable.

The intervening basis is either homogeneous, finely granular, or fibrous; sometimes the fibres are distinct and can be isolated.

The simplest form of cartilage, viz. that composed of cells only, is met with in the *chorda dorsalis* or notochord of embryos, in the adult skeleton of many fishes, the tentacles of the Acalephæ, and in the cartilage of the ear of many mammals. The protoplasm in these cells often exhibits radiating striæ in which currents are visible. The structure is beautifully seen in the *chorda dorsalis* of a young tadpole or *Triton*, or in the ear of the mouse (Pl. 49. fig. 38). In

Fig. 101.



Magnified 350 diameters.

Cells from the gelatinous nucleus of the intervertebral ligaments. 1 *a*, large primary cell with a septum formed by two secondary cells, and five tertiary capsular cells or cells of the second generation with concentric walls and shrunk nuclei *c* in the small cell-cavities. 2, primary cell *a*, with two secondary cells separated by a delicate septum *b*, with thickened walls, a small cavity and a shrunk nucleus *c*.

the latter instance, each cell is filled with a globule of oil, which must be separated by digestion in ether before the cell-structure can be properly examined; but boiling on a slide in solution of potash, or the addition of sulphuric acid will liberate the globules of fat from parts of a section. This variety of cartilage exactly resembles in appearance a section of vegetable cellular tissue.

The second variety of cartilage, in which the basis is more abundant and homogeneous or finely granular, true or hyaline cartilage as it is called (Pl. 49. fig. 39), is met with in the larger cartilages of the respiratory organs, in the articular, costal, ensiform and nasal cartilages. In this the cell-walls are closely adherent to the intercellular basis, so that they are rarely visible without the use of reagents. The cells are most numerous in the articular cartilages, and are mostly smaller the further they are from the bone. Their long axes are placed perpendicularly to the axis of the bone, except in a thin layer next the surface of the joints, in which they are parallel to the surface. Both the cells and the nucleus of this cartilage exhibit a fibrous network.

The third variety of cartilage forms fibro- or reticular cartilage (Pl. 49. fig. 40). In this, the fibres consist either of white fibrous tissue, forming white fibro-cartilage, as in the intervertebral and interarticular cartilages ; or of elastic tissue, forming yellow or elastic fibro-cartilage, as in the epiglottis, the ear, and the Eustachian tube. It consists principally of fibres, single or in bundles, sometimes running parallel, at others interlacing; and between them lie the cartilage corpuscles. Sometimes the basis of hyaline cartilage becomes fibrous, and true fibres may be found in it.

Bubnoff describes, in cartilage treated with osmic acid, a complex network of canals, passing in all directions through the cartilage.

In regard to chemical composition, the homogeneous basis usually consists of chondrine. The cell-walls are composed of a substance allied to elastic tissue; they are not dissolved by boiling in water, and are acted upon with difficulty by acids and alkalies. The liquid within the cells is probably albuminous; it is coagulated by water and dilute organic acids, and is readily soluble in alkalies.

When sections of cartilage are subjected to the action of Schultze's test, the cells are coloured red, but not the basis.

By macerating hyaline cartilage in dilute acids or warm water, the matrix often exhibits concentric laminæ.

Some staining agents are useful in enabling the components of hyaline cartilage to be distinguished. Thus, the fat-globules are blackened by osmic acid; chloride of gold colours the cells violet; and nitrate of silver stains the matrix (Rutherford).

Bibl. Kölliker, *Mik. An.* Bd. i.; Henle, *Allg. Anat.*; Redfern, *Ed. Month. Journ.* 1851–1854; Mulder (and Donders), *Phys. Chemie*; Frey, *Histol.* 184; Bubnoff, *Ber. d. Wien. Ak.* lvii.; Klein, *Hist.*, 48; Gegenbaur, *Vergl. An.* 27; Rollett, *Stricker's Gewebel.*; and the Bibl. of Tissues.

CASEINE is the proteine constituent of milk. It possesses no microscopic characters.

Some years since, a tumbler containing porter, at the bottom of which was a small quantity of a whitish sediment, was brought to us for examination, suspicion being entertained that the white deposit consisted of some poisonous substance which had been added by a woman with the view of poisoning her husband, the two not being on good terms. The deposit examined microscopically and microchemically was found to consist of an amorphous substance, giving the chemical reactions of a proteine compound, with entangled globules of oil. This rendered it probable that it consisted of the caseine of milk, with globules of butter. It was afterwards recollected that milk had been put into a tumbler kept in the place from which this had been taken; and thus the matter ended.

CASSAVA.—The coarser part of the starch (tapioca being the finer) derived from the tuberous root of the *Jatropha Manihot*, L. (*Janipha Manihot*, Knth.; *Manihot utilissima*, Pohl), a Brazilian plant of the family Euphorbiaceæ. The starch-grains are represented in Pl. 46. fig. 14.

CASSEBEE'RA, Kaulf.—A genus of Pterideæ (Polypodiaceous Ferns), nearly related to *Adiantum*. 3 species: Brazil.

Bibl. Hooker, *Syn. Fil.* 142.

CASSIDULI'NA, D'Orb.—A group of *Foraminifera* subordinate to *Bulimina*. The chambers are alternate in unequal pairs, and form a more or less discoidal, instead of spiral, coil. The aperture is oblique, formed by an inverted slit-like fold of the lower part of the septal face, as in *Bulimina*.

Two British recent species, *C. lævigata* (Pl. 23. fig. 45) and *crassa*, are common; and a few others, with these, are found in all seas, and in the middle and later Tertiaries.

Bibl. Williamson, *Foram.* 68, figs. 140–144; Carpenter, *Foram.* 197; Parker and Jones, *Phil. Tr.* clv. 377.

CATASCO'PIUM, Brid.—A genus of Bartramioideæ (Acrocarpous Mosses).

Bibl. Wilson, *Bryol. Brit.* p. 285; Berkeley, *Brit. Mus.* p. 168.

CATENEL'LA, Grev.—A genus of Cryptonemiaceæ (Florideous Algæ), represented by one British species, *C. Opuntia* (Pl. 4. fig. 21), which is not uncommon on marine rocks near highwater mark. It presents a mass of creeping fibres, from which arise densely matted fronds 1-2 to 1″ high. Colour dull dark purple. The *favellidia* are contained in the lateral capsular bodies (fig. 102); the tetraspores are imbedded in the periphery of the loosely cellular axis (fig. 103).

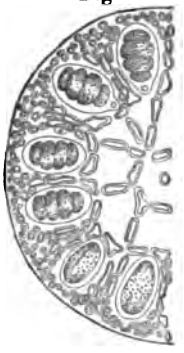
Bibl. Greville, *Alg. Brit.* pl. 17; Harvey, *Br. Mar. Alg.* pl. 20 B; *Phyc. Brit.* pl. 88; *Engl. Bot.* (*Rivularia Opuntia*), pl. 1868.

CATERPILLARS. See Insects.

CATHARI'NEA, Ehrh.—A genus of Polytrichaceous Mosses, containing some of

Fig. 102.

Fig. 103.



Catenella Opuntia.

Fig. 102. Fragment of a frond, with lateral capsular bodies containing the favellidia. Magnified 10 diameters.

Fig. 103. Transverse section of the axis, showing the immersed tetraspores. Magnified 50 diameters.

the *Polytricha* of authors, having a naked calyptra; =*Atrichum* and *Oligotrichum* of Wilson's *Bryologia*.

Bibl. Wilson, *Bryol. Brit.* pp. 202, 204.

CATTLE-PLAGUE or Rinderpest.—This terrible disease requires a brief notice on account of its microscopic relations. Careful examination of the muscles of animals which had died of it showed the presence of "Entozoa." These were found afterwards to be *Psorospermiæ*, and to exist in healthy as well as in diseased animals; so that they had no connexion with the malady. A most copious Bibliography of the parasites infesting cattle is given in Cobbold's work, p. 352.

Bibl. Beale, *Qu. Mic. Jn.* 1866, p. 141 (figs.); Cobbold, *Parasites*, 1879, p. 280.

CAYENNE PEPPER.—This substance consists of the ground seed-vessels of various species of *Capsicum*; it is often adulterated both with substances increasing the bulk, and with mineral colouring-matters. For the detection of the former the microscope is employed, first studying the characters observed in the true unground peppers. Turmeric and rice-flour are named as falsifying substances; red earths, vermilion, and red lead are detected by chemical analysis.

Bibl. That of *Adulterations*.

CECIDOMY'IA, Latr.—A genus of Diptera, of the family Tipulidæ.

C. tritici is the wheat-midge, which deposits its eggs in the flowers of corn. The yellow larvæ wound the ovary, and so cause a form of blight.

C. destructor, the American wheat-midge, or Hessian fly, is still more injurious to crops.

These insects may be found among the ears of corn in the evening during the month of May or June.

Bibl. Kirby, *Linn. Tr.* iii., iv., v.; Westwood, *Intr.* p. 519; Sidney, *Blights of the Wheat*, p. 109.

CE'CROPS, Leach.—A genus of Crustacea, of the order Siphonostoma, and family Caligina.

C. Latreillii. Found on the sun-fish (*Orthagoriscus mola*). Female, length 1", male 1-3".

Bibl. Baird, *Brit. Entomost.* p. 289; V. d. Hoeven. *Handb. d. Zoologie*, i.

CEDAR.—The Cedar of Lebanon is the *Abies* or *Pinus Cedrus*. The fragrant so-called 'cedar,' of which pencils &c. are made, is the wood of *Juniperus virginiana*.

See Coniferæ and Wood.

CELL, Animal.—The tissues and organs of animals, like those of plants, are in great part made up of or derived from cells; but the full-grown structures of animals are strikingly distinguished in general from those of vegetables by the departure from or disguisal of the primitive cellular constitution.

Under the head of Cell, vegetable, the cell is defined as a vesicle or sac consisting of a membrane composed of cellulose, containing within it a nitrogenous structure, the vital part, called the protoplasm or primordial utricle. In animals, as in the earlier stages of many plants, this protoplasm may exist alone, either forming the entire organism, or its parts only, without a membranous envelope forming the true cell or closed sac, as in *Amœba* and analogous organisms; but ordinarily the animal cell, like the vegetable, is a true shut sac, enclosing liquid or gelatinous protoplasmic contents, the membrane, however, being here almost always composed of a nitrogenous compound, and only in a few cases of cellulose or allied substances such as prevail in the solid parts of plants.

The membrane of animal cells is ordinarily transparent and colourless, mostly smooth, and so thin as to exhibit only a single boundary line; more rarely the membrane is tolerably firm, presenting a measurable thickness,—while it is sometimes very thick, and appears to consist of several layers.

Occasionally the membrane has a granular appearance, arising from projections dependent on granules lying on the inside. No structure can be detected in the cell-membrane itself.

The membranous cell generally contains a liquid or semifluid protoplasm, the consistence of which varies; in this float, or are suspended, molecules, granules, globules, or other very minute cells. But modern observations indicate the existence of a network of filaments, traversing the substance of the protoplasm. In most cells, we also find one or more of those bodies which are termed *nuclei*, often attached to some part of the cell-wall; in these again, a network of fibres is stated to occur. The nuclei contain *nucleoli*. The cell-contents likewise include, in particular structures, products of secretion—matters separated by the cells from the circulating fluid, as in the cells of the renal epithelium, &c.,—also crystals, pigment, &c.

The *forms* presented by animal cells are not so varied, or generally so geometrical, as those occurring in the cells of vegetables.

In regard to *size*, the largest are the yelk-cells of ova, especially of Birds and Reptiles, and of some animals consisting of a single cell, as certain of those curious organisms the *Gregarinæ*.

The *nuclei* are usually spherical or lenticular, non-contractile, transparent, and colourless or yellowish. They are sometimes solid or homogeneous; at others they are vesicles, with a very delicate membrane. They sometimes contain, exclusively of the nucleolus, a transparent colourless or yellowish liquid, in which water and acetic acid produce a precipitate of granules resembling those existing in the cell-contents; hence in the ordinary manner of examining them they seldom present their natural transparency. The nuclei seem to be secreted or formed by the protoplasm, and are regulators of the vital phenomena.

The *nucleoli* are rounded, well defined, very minute, sometimes immeasurable.

Chemically, the cell-membrane ordinarily consists of a proteine compound; it is mostly dissolved, or rendered so transparent as to become invisible, by acetic acid and solution of potash; thus differing in a striking manner from that of vegetable cells. Cell-membranes composed of cellulose occur in some animals, as in the Tunicata &c.; it is detected here, as in plants, by the action of iodine and sulphuric acid. The nucleoli consist also of a proteine compound; they are soluble in potash, but not in acetic acid. The action of potash distinguishes them from globules of fat. The carmine-ammonia solution has a much more rapid and powerful dyeing action upon the protoplasm and the nuclei than upon the cell-walls.

It must be remarked that the appearances interpreted to be nuclei and nucleoli are frequently not respectively identical in kind; the nuclei are sometimes homogeneous, at others true cells; sometimes they relate to the formation of the cell; at others they are young secondary cells, vacuoles, &c.; the same applies to the nucleoli. These important points have not hitherto received sufficient attention.

Cells, or rather their protoplasms, are endowed with peculiar vital forces, by which they are capable of free movement, absorption, and the elaboration of the absorbed matter; of growth, reproduction, and of secretion. The entire organism of the higher and most of the lower animals consists, at a certain period of life, of cells, but sometimes of protoplasm alone.

Formation of Cells.—Cells are formed in two ways: either from a blastema, protoplasm, or formative substance existing without, or contained within, other cells. The protoplasm is a semifluid substance, consisting of proteine or albuminous matter, fatty matter and salts.

The formation of cells *in a free blastema* is not a general process; in fact, its occurrence is now mostly denied. The only instances of its supposed occurrence in man and the higher animals were in the formation of the chyle and lymph corpuscles, the cells of certain glandular secretions (seminal cells, ova), and glandular organs (the closed follicles of the intestine, the lymphatic glands, the splenic corpuscles with the splenic pulp, and the thymus); lastly, of the cellular elements in the impregnated uterus, in the *corpus luteum*, the marrow of fœtal bones, and in the soft ossifying blas-

Fig. 104.

Magnified 350 diameters.

Contents of a Malpighian body from the spleen of an ox. *a*, small, *b*, larger cells; *c*, free nuclei.

temata. In the case of the chyle and the spleen, at the commencement of cell-formation, there occur roundish, apparently homogeneous bodies of 1-11000 to 1-5600″ diameter, which, increasing in size, soon appear distinctly as vesicles (fig. 104), and, on the addition of water, exhibit an internal large body resembling a nucleolus, as also several granules. The minute details of this stage of the process of formation are not accurately known. As soon as the nuclei are formed, cell-membranes are formed around them, but not always in the same manner. Sometimes the cell-wall is deposited directly around the nucleus, so that it is but little larger than the latter; at others the nucleus becomes surrounded by a larger or smaller quantity of protoplasm which becomes more solid, and around which the cell-membrane is subsequently deposited. The latter occurrence has hitherto only been satisfactorily observed in the case of the ovum, in which the germinal vesicle, *i. e.* the nucleus of the ovum-cell, which is formed first, becomes surrounded by a quantity of yelk, before the vitelline membrane is formed. On the other hand, the formation of the cell-wall directly around the nucleus has been supposed to take place in all the other localities mentioned above; and to be especially shown by the occurrence of free nuclei and larger cells, together with very small cells closely surrounding the nuclei, or separated from them by a slight interval only. It is possible that, in this instance also, the cell-membrane, even at its first formation, may be separated from the nuclei by a quantity of protoplasm too minute to be detected.

The free formation of cells has been observed by Weissmann in insects during development.

The extracellular formation of cells is unknown in plants. And probably, when observers are agreed, it will be found that all protoplasts and cells are derived from parent protoplasts by some form of segmentation.

The *endogenous method*, or the formation of cells within others, is very common, and may be readily observed in the tissues of embryos. In the most ordinary form of this kind of cell-formation, an original or parent-cell produces within it two secondary cells, which from the first completely fill it. The first phenomenon observed in the parent-cell is the increase of the nucleus, which acquires two nucleoli, becomes elongated and resolved into two nuclei. After this the nuclei separate from each other, and a partition is formed between the cells, dividing the parent cell into two perfectly distinct spaces, each of which encloses a nucleus and half of the contents (fig. 100). The exact manner in which the increase of the nucleus occurs is not certain; but it appears that the nucleoli always become resolved into two by subdivision, and then separate from each other. In the nuclei, which at the same time become elongated, the first trace of division is then usually a median partition, which in favourable instances appears to arise from the presence of two secondary cells in close contact by plane surfaces and entirely filling up the parent nucleus. Very frequently nothing is seen but first an elongated nucleus with a partition and two nucleoli, and then two hemispherical nuclei in contact by their plane surfaces (fig. 105), no endogenous

Fig. 105.

Magnified 350 diameters.

An elongated nucleus, and one containing two secondary nuclei, from the ovum of an *Ascaris dentata*.

nucleus-formation being perceptible; in this case, division of the nucleus has taken place, the parent-nucleus containing two nucleoli becoming finally resolved into two by a deeper and deeper constriction. This mode of cell-formation is often continuously repeated, frequently so long as the growth of the organism continues. The parent-cells then either continue their existence as such, or they disappear sooner or later as histologically distinct formations, and become consolidated with the substance connecting the cells.

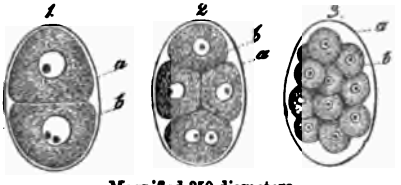
The endogenous cell-formation, which agrees essentially with the formation of cells in a free protoplasm, is well established in the case of the young cartilages of all animals; it also probably occurs in embryonic organs in general, in which, from the period at which they consist of true cells, the entire growth depends upon the multiplication of the existing cells without free cell-formation. It also occurs in pathological products, as in cancer.

In addition to this—the most common

kind of endogenous cell-formation, there are others, viz. :—

a. In the ova of most animals at the earliest period of development, a peculiar process occurs called the segmentation of the yelk, which must be regarded as preliminary to the formation of the first embryonic cells; and which, as the ovum bears the import of a simple cell, falls under the type of endogenous cell-formation. The essential features of the segmentation are as follows. After the original nucleus of the ovum-cell —the germinal vesicle—has disappeared in consequence of impregnation, the granules of the yelk no longer remain aggregated into a compact mass as before, but become distributed throughout the entire cell. The first sign of commencing development is then constituted by the formation of a new nucleus—the first embryonic nucleus, around a new nucleolus, which acts as a centre of attraction to the yelk, and causes it to reunite into a globular mass—the first globule of segmentation. In further development, two new nucleoli are formed from the first nucleus by endogenous growth, which, as soon as they are set free by the development of the parent nucleus, become separate from each other, act as new centres to the yelk-granules, and thus the first globule of segmentation becomes resolved into two. The increase of the nuclei and of the globules of segmentation continues in the same way, the first always preceding, until a very large number of small globules are present, which entirely fill up the yelk-cell; sometimes, but exceptionally, the globules are not resolved until the nuclei have become

Fig. 106. Fig. 107. Fig. 108.



Magnified 350 diameters.

Three ova of an *Ascaris nigrovenosa*: 1, in the first; 2, in the second, and 3, in the third stage of segmentation, with two, four and sixteen segmentation-globules. *a*, outer coat of the ovum; *b*, segmentation-globules. In 1, the nucleus of the lowest globule contains two nucleoli; in 2, the lowest globule two nuclei.

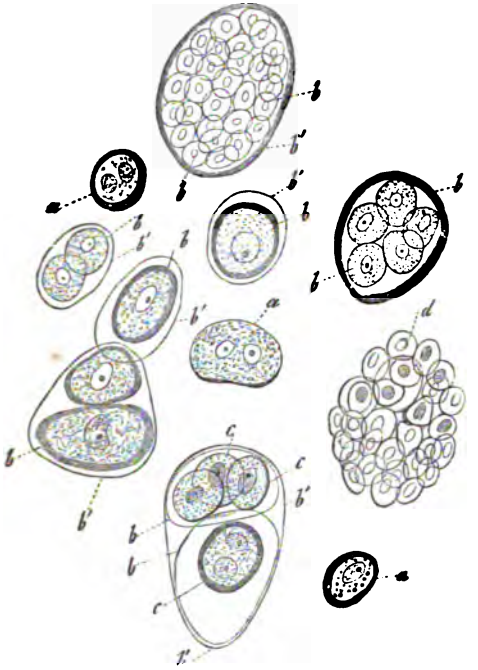
increased to three or four, so that three or four globules are formed from each, instead of two. This process is termed total segmentation, because here the entire yelk is applied to the newly-formed nuclei: partial segmentation agrees with this in all essentials, and only differs from it in the circumstance that in it, not the whole of the yelk, but a larger or smaller part of it, varying in different animals, envelopes the nuclei in process of formation (figs. 106–108).

When the process of segmentation has reached a certain stage, the segmentation-globules become surrounded with membranes and form true cells, whence it appears justifiable to arrange this process with endogenous cell-formation. In fact it is nothing more than a preliminary to cell-formation in the ovum-cell, and only differs from the ordinary phenomena of this kind in the circumstance that—first, the nucleus of the parent-cell or the germinal vesicle in most cases has nothing to do with it; secondly, the parent-cell itself persists; and, thirdly, the portions of the contents formed in it by the successive increase of nuclei do not assume the form of cells until subsequent generations. This view is moreover justified, since the cells formed from the last segmentation-globules continue for a long period to multiply by endogenous production (or division); and the entire segmentation-process may be regarded as a kind of endogenous cell-formation, in which, on account of the rapidity with which the nuclei increase, in the first generation of globules it does not come to the formation of membranes (see Ovum).

b. In some respects allied to segmentation, are those forms of endogenous cell-formation in which a greater or less number of secondary cells are formed within persistent parent-cells, as seen here and there in cartilage, the suprarenal capsules, the pituitary body, &c. In this case, either two secondary cells are formed in the usual way in a cell, almost or entirely filling it, and from these other generations, either free or all or individual ones enclosed in parent-cells of the second and subsequent generations, or only one secondary cell is formed in a cell, whence cell-formation then proceeds in either manner (fig. 109), or the secondary cell is formed in a bud-like protrusion of the parent-cell (see Echinococcus).

The formation of a larger number of nuclei within cells, which frequently precedes cell-formation, but may also exist alone, may be well arranged under endogenous cell-growth. Even in ordinary endogenous cell-formation (and also in seg-

Fig. 109.



Magnified 350 diameters.

Cartilage-cells from a fibrous velvety articular cartilage of the condyle of a human femur; all lying in a fibrous basis, and easily isolated. *a*, single cells, with or without thickening of the cell-wall, and one or two nuclei: *b*, secondary cells, or cells of the first generation, with one or two nuclei—one, two, five, and many cells in the parent-cells *b'*; *c*, cells of the second generation, one to three in those of the first, *b b*; *d*, free group of secondary cells.

mentation) we not unfrequently find three and four nuclei in one parent-cell, so that then, instead of two, a larger number of secondary cells are formed at once, as *e. g.* in the liver-cells of embryos. In certain animals (*Cucullanus*, *Ascaris dentata*, *Distoma*, and the Cestoidea), instead of segmentation-globules, in the first stage of development, nuclei only are formed in the ovum-cell, which do not become surrounded by cell-membranes until they have accumulated into a large heap by successive endogenous growth. The same appears to take place in the cells of the germ of the Crustacea, in which from ten to twenty nuclei frequently exist. The numerous nuclei, however, in the seminal cells of most animals appear usually to have no connexion

Fig. 110.

Magnified 350 diameters.

Ivory-cells from the tooth of a dog.

with cell-formation, because the seminal filaments are developed within them; and the same applies to those cells of the lower animals, the numerous nuclei of which are converted into urticating organs. Whether in these cases the nuclei multiply by division or endogenous growth is unknown.

Cell-formation by division has been observed in the coloured blood-corpuscles of the embryos of Birds and Mammalia, and the earliest colourless blood-corpuscles of the larvæ of frogs (tadpoles); it also probably occurs in the colourless blood-corpuscles of embryos and the chyle-corpuscles of adult Mammals. In all these cases the cells first become elongated, and the single nuclei appear to become divided into two; the cells are then constricted in the middle and finally resolved into two, each with a nucleus (Pl. 49. fig. 36).

A peculiar kind of cell-growth, most nearly allied to division, occurs in the cells of the ivory of the teeth; in which the nuclei, while continually elongating, enlarge from time to time and become constricted, so that whilst that portion next the ivory ossifies, the remainder serves to a certain extent as a reserve for the subsequent formation of newly ossifying portions (fig. 110).

The term cell is frequently used in a totally different sense, to denote a partially closed space, or the cup-like body enclosing

the space; as in the case of the cells of a Polype, or Polyzoon, the cells of a sponge, &c.

Bibl. *Treatises on Physiology*; Schwann, *Einstimmung* (*Syd. Soc.*); id. *Wagner's Physiol.*; Valentin, *Phys.*; Kölliker, *Gewebelehre d. Menschen* (and the *Bibl.* therein); Siebold, *Zeitschr. f. wissens. Zool.* i. p. 270; Rollett, *Stricker's Handbuch* (*Syd. Soc.*) i.; Frey, *Histologie*, and the *Bibl.*); Cohnheim, *Virchow's Archiv*, xl.; Recklinghausen, *ibid.* xxviii.; Weissmann, *Zeitsch. f. rat. Med.* 3rd ser. xv.; Klein, *Qu. Mic. Jn.* 1878 and 1879, and *Hist.*; Carpenter, *Phys.*; Strassburger, *Zellenbildung*, 1880; and the *Bibl.* of Tissues.

CELL, Animal, *artificial formation of*.—When oil is immersed in a liquid containing albumen, it becomes surrounded by a layer of coagulated albumen, forming a cell; and this cell will exhibit the phenomena of endosmose and exosmose in the same manner as any natural cell. The same phenomenon has been observed with metallic mercury and albumen, chloroform and albumen, chloroform and chondrine, &c. It has not yet been satisfactorily explained. The natural formation of cells has been supposed to be produced by this method; but it appears inapplicable to the purpose, as the nuclei or masses of blastema, around which natural cells are formed, do not consist of fat.

See Concretions.

Bibl. Ascherson, *Müller's Archiv*, 1840, p. 44, &c.; Wittich, *De hymenogonia albuminis*, Regiomont. 1850; Harting, *Neder. Lanc.* Sept. 1851; Melsens, *Bull. de l'Acad. de Belg.* 1850; Panum, *Archiv f. path. An.* iv. 2; Bennett, *Ed. Mn. Jn.* viii. 166; Kölliker, *Geweb. d. Mensch.* 10; Schmidt, *Taylor's Scientific Memoirs*, v. 10.

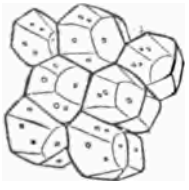
CELL, Vegetable.—The definition of the term *cell* in vegetable anatomy, ordinarily adopted, is, a closed sac composed of an (originally) imperforate membrane formed of the chemical substance called cellulose, this membrane enclosing more or less fluid contents so long as the cell retains its vitality. All the solid permanent structures of plants are formed of cells answering to this character, the differences of the full-grown tissues depending upon peculiar modifications and alterations of the original cells. In animal structures, the term cell is commonly applied, not only to structures really analogous to the cells of plants, but also structures analogous to the *contents* of the true cellulose plants, which, however, are indeed in all cases the important vital parts of the structure. All young vegetable cells contain a quantity of semifluid nitrogenous formative substance called *protoplasm*, which may be chiefly adherent as a thickish and more or less continuous layer on the inside of the cellulose wall, forming a kind of lining to it, and therefore enclosing all the rest of the contents, in which case it forms the *primordial utricle* of Mohl; or this dense protoplasm may fill up the whole cavity of the cell as a gelatinous mass. Or the gelatinous mass of protoplasm may emerge from the cellulose sac, with a definite form and organization, furnished with cilia enabling it to move freely in water; and here the protoplasm presents itself as independent, and indeed as the primary element of all cellular tissue: it occurs in this condition in the zoospores of the Confervoid Algæ. These free bodies, devoid at first of a cellulose wall, are evidently analogous to the corpuscles of 'sarcode' constituting certain animals, such as *Amœba*, while the cartilage-cells &c. of animals are analogous to the cellulose sacs of plants.

In this work, then, the word cell, as applied to organic structures, is always used in its ordinary sense. Häckel's unnecessary terms Cytode for the simple protoplast, and Cell for the nucleated protoplast, are ignored in botanical works.

Form.—Cells may present almost every possible modification of form; and this depends on two sets of conditions—the original development and shape, and the mode of growth and expansion. It is frequently stated that the primary form of all vegetable cells is that of a sphere, or at all events that this is the *type*, from which all the others must be considered deviations. This is true only so far as it is intended to signify that most cells which originate free in the midst of fluid, suffering no external compression, have a globular form; and that in numerous cases where cellular tissues are very lax and free to expand in all directions, the component cells acquire a globular form during the enlargement to their full size. But in a very large majority of cases the cells do not originate in a free condition, they are produced by subdivision of older cells, and consequently, when first developed, they have the shape of the half, the quarter, or whatever segment it may be of the parent-cell; moreover, in a majority of these cases the mode of expansion also depends upon a special law of the particular tissue, or even

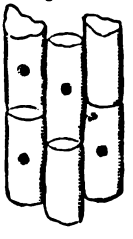
of such tissue in the particular group to which the plant belongs, and not upon any general law of globular expansion. The above law does prevail widely in some families, as in the Fungi; and we very frequently see it prevailing in pith up to a certain period: but it will not hold as a general rule; for the lax tissues of leaves, of succulent stems, &c. offer most striking deviations, as do also the varied and often elegant forms of lower Algæ. It is frequently stated in books, that the effect of pressure on cells having a tendency to become globular, is the production of a dodecahedral form; but this again is far too sweeping a generalization, and the real fact is that globular cells of equal size, expanding in a confined space, often become twelve-sided by mutual pressure; but far more often the cells of a tissue are of diverse size, and hence a polyhedral form is much more common (fig. 111). Cells may be

Fig. 111.



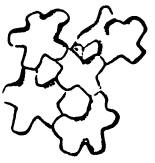
globular, as in the Yeast-plant, and many lower Algæ, in the lax tissue of young pith of many Dicotyledons (Pl. 47. fig. 14), &c.; oval, as is much more common in parenchymatous tissues; squarish, as in cork (Pl. 47. figs. 16, 17); or tabular, as in the epidermis of numerous plants, under which circumstances the side walls may be square, rhombic, hexagonal or irregular, as in many petals; and the outlines may also be undulated or even beautifully zigzagged, as in the leaf of *Helleborus fœtidus* &c., the petals of many flowers, or in the leaf of the Pineapple (Pl. 47. fig. 15), &c.; while the upper exposed face may be flat or vaulted, as in most petals, or even papilliform, as in the petals of the Sweet William and of most flowers with glistening surface. Cells may also be cylindrical, and then either with flat ends (fig. 112), as in the parenchyma of many Monocotyledons and in the filaments of Confervæ, or

Fig. 112.



rounded ends or attenuated ends, as in wood and liber tissue generally; or they may be prismatic, and then square or six-sided, as in stems of most herbaceous plants; spindle-shaped, as in a large number of woods, such as that of Conifers, Box, &c.; and, in fact, of almost every conceivable form. In lax tissues, the walls of the cells often grow very unequally at different points, whence result angular projections, by which the cells ordinarily cohere (fig. 113); or these grow out into arms or rays, producing stellate cells, as in the pith of the Rush (Pl. 47. fig. 18), and the parenchyma of many aquatic plants, in the leaf-stalk of the Banana, &c. Cells which are free, as in the lower cellular plants, sometimes grow out into long tubular structures such as *Vaucheria*, with a continuous cavity, and indeed sometimes ramify into a complication of branches, as in *Bryopsis* and *Codium*, while in *Botrydium* (fig. 75) the globular cell sends down a number of root-like filaments which are mere protrusions of its own wall. The cells of *Chara* attain very large size. In the Flowering plants we have an example of extraordinary growth of a single cell in the pollen-tubes, which, in some cases, become as much as three inches long.

Fig. 113.



Size.—The dimensions of cells vary to infinity, and, indeed, often extremely in one and the same tissue, but not as a rule. And the diameter of cells is very frequently incomparably less than the length, as in all filamentous and fibrous cells. Taking a very general view, we may say that parenchyma-cells vary from 1-250 to 1-1000″ in diameter; but the spores of many Fungi measure no more than 1-6000 to 1-8000″, while the cells of the juicy parenchyma of many fruits and piths attain as much as 1-100″.

The smallest cells appear to occur in *Palmella hyalina*, where they measure the 1-83,000″. In elongated cells, such as those of liber and most woods, the diameter is ordinarily less than in parenchyma, while the length is far greater: thus in wood the length varies from about 1-40 to 1-12″, while the diameters are respectively 1-300 and 1-100″; in liber the length may extend to 1-8 or 1-4″, with a diameter of 1-800 and 1-400″. (See FIBRES.) Hairs composed of a single cell often attain a great length,

as in Cotton, where a single filamentous cell may measure 1 to 2″. (See TISSUES, VEGETABLE.)

Cells may be examined either *in situ*, as parts of tissues, or free, separated naturally or artificially. For the first it is simply requisite to make fine slices with a razor, in various directions through the structure; if soft or thin, it should be placed between the two halves of a split vial-cork and sliced with the cork, the cork being afterwards removed from the slide with a needle. Slices of many kinds of cellular tissue are made more clear by the addition of a little diluted sulphuric acid, which, however, often swells up some of the layers.

For examining isolated or nearly separate cells, we may take the lower Algæ or Fungi, or germinating spores of the higher plants, or we may separate the cells of the tissues of higher plants. The parenchymatous tissues may usually be separated into their elementary cells by maceration in water: the decomposing ends of flower-stalks which have been in water several days will generally afford tissue in such a state that it may be broken up with a needle; in the pulp of ripe fruits, such as currants, strawberries, &c., mere pressure separates the cells. Boiling will do with some of the denser kinds; while for the woody tissues it is requisite to heat fragments with a particle of chlorate of potash and a drop of nitric acid (or let them macerate for 12 to 24 hours), and wash them well with water: liber-cells, woody cells, &c. may be isolated by this means; or still better by treating them with chromo-sulphuric acid.

Formation of Cells.—This subject has undergone a great amount of investigation during the last few years; and the views which have been propounded at various times have conflicted strongly in many points. It would be exceeding our limits, however, to enter upon a critical examination of the theories of cell-development; and we shall therefore confine ourselves to a brief account of those phenomena and laws of the reproduction of cells upon which the diversity of opinion only affects subordinate particulars.

All vegetable cells (using this term in the sense of the *cellulose sac with contents*, as defined above) in which the capacity for reproduction exists, contain an internal structure or protoplasm, varying in its condition and appearance at different epochs and in different plants or parts of plants. This structure often forms a semifluid layer lining the cellulose wall of the cell. All the other cell-contents are enclosed or imbedded in this protoplasm; and with it they collectively constitute what is called by some authors the *endochrome* of the cell.

In a very large number of cases, we find in the protoplasm at this time, a peculiar body called the *nucleus*, to which some writers attribute great importance in the dovelopment of cells. Its nature is not well defined; but in the best-observed cases, it consists of a small globular or lenticular mass, apparently composed of the protoplasm in a condensed and granular (solid) condition. The nucleus is usually present in the cells of the higher plants, but is often absent in those of the Thallophytes. It mostly exhibits one or more bright granules or points in its substance, which are called *nucleoli*. Many authors consider this body of the first importance in cell-development; but as we are by no means satisfied as to the character of its agency, its peculiarities and its relation to the cell are spoken of separately under the head of NUCLEUS (Pl. 47. figs. 8, 9 *n*).

The ordinary development of new cells depends upon the division of the protoplasm of existing cells into two or more portions, which, becoming independent centres of life, produce new cellulose membranes, and become new cells. The phenomena in which this law is manifested are far more varied than would be imagined from this simple statement. The numerous subordinate modifications, however, may be arranged under three principal heads:—1. *Cell-division*, sometimes called *merismatic* cell-formation; 2. *Cell-division with liberation of the new cells*; 3. *Free cell-formation.*

1. *Cell-division* is the process which occurs in all reproduction of cells connected with vegetative growth or increase of the mass of existing structures. This is the manner in which the cells are multiplied in the growth of the thallus of the inferior plants, and in the growth of the stems, leaves, roots, and other organs of the higher plants. It occurs also in the formation of the *basidiospores* or *stylospores* of Fungi, the *spermatia* of these and Lichens, of *gonidia* in the Lichens, and *conidia* in the Fungi. The essential fact observed in all the cases is, the division of the protoplasm of the parent-cell into two or more distinct portions, each of which secretes a layer of cellulose over its whole surface; and thus, when the two are in ap-

position, a partition is formed dividing the parent-cell into two or more parts. The form of the secondary cells depends of course on that of the parent-cell at the time of division. In the case of cellulose tissues, such as those in the *punctum vegetationis* of the buds of the higher plants, in *cambium*, &c., the division is ordinarily into two parts, which respectively grow until equal in size to the parent; and either both or only one of these divides again in the same way, and so on, until the whole structure is completed. It is evident that the external forms of all cellular structures must depend greatly upon the laws of division of the cells of plants. For example, supposing we start from a single square cell, when this divides into two halves, and these grow to equal the parent-cell, we have an oblong figure; if the half-cells divide again in the same direction, we shall in time get a long filament; and if *both* new cells divide again each time, the filament will grow much longer in a given time than if only the *end-cell* continually divided, leaving one new cell behind it at each division. If the pair of cells produced by the first halving divide at right angles to the first division, a square group of four cells results; and if this law continues to act, a flat plate of cellular tissue will result. Further, if the cells also divide by horizontal partitions (in the third direction of space), the mass of cells will gradually acquire thickness or height as well as length and breadth. Lastly, if the cells of particular regions cease to divide sooner than others, irregular or complex but definite structures will be produced—as those parts where the cell-division goes on will emerge from the general mass, in the Cellular plants as lobes, and in the higher plants as conical bodies which are gradually developed under similar laws into the organs. The diversities of internal organization depend also to some extent on the same laws, but less on these than on the laws regulating the forms which the cells acquire when full-grown.

Cell-division may be observed most easily in the lower Cellular plants, or in the simpler structures (such as hairs) of the higher plants (Pl. 47. figs. 8, 9). The Confervæ afford exceedingly favourable opportunities, as do also the filamentous or thalloid structures of germinating Mosses, Ferns, microscopic Fungi, &c. The behaviour of the parent-cell before division exhibits some diversities. If a simple filament is increasing by cell-division, the cylindrical parent-cells merely elongate a little before dividing transversely. If the filament is to branch, the wall of the parent-cell bulges out gradually at the point where the branch is to appear; the bulging soon becomes a pouch, and this pouch is soon shut off by the formation of a partition at its base. Bead-like rows of cells likewise divide by budding in this way, as may be observed, for instance, in the Yeast-plant: the new cell first appears as a little 'bubble' on the side of the parent, with its cavity continuous; and after it has acquired a certain size, its protoplasm detaches itself from that of the parent, and a partition is formed at the point whence the second cell emerged (Pl. 26. fig. 23).

Another point which must be noticed here, is the question whether the parent protoplasm divides *instantaneously*, at a given epoch, into the new utricles, or whether it parts gradually, by a sort of constriction advancing from the surface towards the centre, roughly comparable to what occurs when a ligature is slowly drawn tight round an elastic tube, or when a bar of soap is cut in two by passing a string round it and gradually drawing the loop tight. It seems probable that the segmentation of the protoplasm is always gradual; and it is certain that it is so in many cases. Its gradual constriction has been observed in those Confervæ where the protoplasm forms a hollow sac, lining the whole internal surface of the parent-cell; it may be traced in the larger Confervæ, in *Spirogyra*, &c., by keeping the plants growing in water under the microscope. It appears that the division is generally completed during the earlier hours of the morning.

2. *Cell-division with liberation of the new cells.*—The first step in this process is analogous to what takes place at the outset in the preceding set of cases; but we find much more important modifications here. This is the mode of development of spores of the Ascomycetous Fungi, of the spores and tetraspores of the Algæ, the spores of Lichens, the spores of all the higher Cryptogamia, the active gonidia or zoospores of the Algæ, the parent-cells of the spermatozoids or active spiral filaments of the higher Cryptogamia, and of the pollen-grains of the Flowering plants.

The general character is: Division of the whole protoplasm into segments, which either acquire a cellulose coat within the parent-cell before they are set free by its solution or bursting, or escape from the

parent-cell without a cellulose coat, and secrete this afterwards.

The following modifications occur:—

a. Division of a nearly solid protoplasm into four, either directly or by two halvings. This occurs in the development of pollen and of the spores of Mosses, Ferns, &c. The parent-cells of the pollen or spores become free in the interior of the anther or sporange, by the solution of the walls and septa of their parent-cells. The protoplasm of the free cells divides into four segments, entirely filling the cell. After this, either partitions are formed between these (pollen-cells), to be subsequently dissolved, or they at once clothe themselves with a cellular coat (*Marchantia*). In either case, they ultimately lie free in the parent-cell, which is itself finally dissolved (Pl. 47. figs. 10–13).

b. Division of a homogeneous protoplasm into a large number of segments, each of which acquires a cellulose coat, the whole of the new cells lying closely packed but free in the parent-cell. This occurs in the antheridia of the higher Cryptogamous plants, in the formation of the parent-cells of the spermatozoids, also in the formation of the parent-cells of the spores and the elater-cells of the Hepaticæ. The formation of the spores in the asci or thecæ of the Ascomycetous Fungi and the Lichens belongs either to this or the preceding case (Pl. 37. fig. 12).

c. Division of the homogeneous protoplasm into segments which do not acquire a cellulose coat until after they are discharged from the parent-cell. This occurs in the development of the zoospores of most of the Confervoideæ (*Cladophora*, *Bryopsis*, *Achlya*, *Ulothrix*, &c.), where the primordial utricles become free in the cavity of the parent-cell when they divide, and break their way out into the water, where they form a cellulose coat after they have swum about freely for some time by means of their cilia.

d. Division of a sac-like protoplasm into a number of portions, which appear at first as papillæ on the walls of the cell, and finally become isolated in the cavity. This occurs in the development of the gonidia of *Hydrodictyon*, *Botrydium*, &c. These last two cases are connected with *a* and *b*, by the circumstance that the zoospores or active gonidia are replaced, under certain circumstances, by cells; that is, the bodies produced in this way acquire a cellulose coat before they leave the parent-cell.

Numerous intermediate conditions occur which connect all these together; and the last case, *d*, does not differ essentially from what takes place in the formation of the endosperm-cells, placed under 3.

3. *Free Cell-formation.*—Here the new cell is formed by a portion of the parent protoplasm separating itself from the rest of the protoplasm, assuming a globular or oval form, and secreting a cellulose membrane upon its surface, so as to form a new cell lying free in the cavity of the parent primordial utricle. The most remarkable instance of this case is the formation of the germinal vesicles in the embryo-sac of the Flowering Plants (Pl. 47. figs. 1–4); but this is denied by Strassburger. Other cells sometimes occur, formed in the same way, at the opposite end of the embryo-sac. The embryo-sac also frequently becomes filled, after fertilization, by a large increase of free cells developed out of the layer of protoplasm or primordial utricle lining the walls; these (*endosperm-cells*) accumulate in the sac, and sometimes become consolidated into a tissue (albumen) in which the embryo lies imbedded; in exalbuminous seeds they are re-absorbed during the growth of the embryo. The embryo itself is developed from the germinal vesicle by cell-division such as is described under § 1 (Pl. 47. figs. 5, 6).

Cell-formation also occurs, without division, in cases where the entire contents of a cell separate from the parent, and form a new organism (rejuvenescence)—as in *Stigeoclonium*, *Œdogonium*, and other Confervoid Algæ.

Here also must be referred the new cell-formation resulting from Conjugation.

Karsten considers that the formation of every cell within a living organ is original; and that the cell is not divided into two new individuals by transverse septa or proliferation.

The hypotheses of the independent origin of cells from organic substances by *generatio æquivoca* seem to require no notice; but allusion may be made to certain curious phenomena which have been called 'abnormal cell-formations,' occurring in some of the Confervoids. The protoplasm of the Siphoneæ is very apt to collect into globular masses in injured filaments; and these globular masses apparently acquire a cellulose coat in some cases: they have been observed in *Vaucheria* and *Bryopsis*; a somewhat similar phenomenon often occurs in the contents of the cells of *Spirogyra*. It

appears to be a kind of gonidial reproduction, in which portions of the living contents are enabled to save themselves from the general decomposition. (See PSEUDOGONIDIA.) Some forms which we incline to refer here, have been described as distinct genera and species of parasitic Algæ; on this subject see PARASITES, CHYTRIDIUM, PYTHIUM, and AMYLOBACTER.

Membrane.—In all young organs of succulent structures, and all the delicate tissues of the higher plants, and in the majority of the Cellular plants in almost the entire organization, the cellular membranes consist of a thin structureless pellicle, possessing a considerable degree of toughness and a certain amount of elasticity. (C. J. Agardh has indeed asserted that cell-membrane is composed of spiral fibrous structure; but this doubtless is an error as regards the primary membrane.) It is readily permeable by water, while no orifices of any kind can be detected in it; but young, and indeed soft cell-membranes generally, imbibe more or less water, and swell to some extent, often becoming more or less gelatinous. It is stated by Schleiden that the membranes of nascent cells are soluble in water, but general experience does not confirm this statement; the only approach to a corroboration of it that we have met with, is in the lower Algæ: the zoospores are often extruded in the interior of an extremely delicate sac formed of cellulose, which almost immediately vanishes and sets the zoospores free. The external membranes of many of the filamentous and unicellular Algæ become gelatinous, and gradually dissolve away as the inner membranes are successively deposited, forming a gelatinous coat, as in *Protococcus*, *Nostoc*, Desmidiaceæ, Diatomaceæ, *Zygnema*, Oscillatorieæ, &c.; the same also takes place in the development of spores and pollen-grains, which are set free by the parent-cell membranes becoming dissolved. This, however, is scarcely direct solution in water, and comes rather under the head of decomposition.

Young and delicate cell-membranes are perfectly transparent and colourless, as is seen in the Yeast-plant, in the mycelium of Mildews, in the cellular tissue of tuberous structures like the Potato, and in pith (after the mucilaginous cell-contents have been removed). As they grow older, they often become coloured, sometimes very deeply, which is supposed, however, to depend on the infiltration of foreign matters. In the state of simple cell-membranes, where no infiltration of foreign matter has occurred, the application of sulphuric acid of moderate strength, with solution of iodine in solution of iodide of potassium, brings out a bright blue colour; and this is regarded as a test for cellulose, the universal basis of vegetable cell-membrane.

When the cell has attained a certain age, new deposits of membranous substance take place inside; and the walls thus acquire more or less thickness, together with a very varied appearance, according to the character of the deposits. The new layers are known as SECONDARY LAYERS; and the term *Cell-wall* is perhaps the most convenient collective term which can be applied to the various structures produced by the deposition of new layers of cellulose upon the inside of the primary cell-membrane. Although these new deposits are thin layers of cellulose like the primary membrane, they are rarely so totally devoid of detail structure, and in the majority of cases exhibit orifices and irregularities of the most striking character. Moreover, in one class of cases, they are not deposited as a continuous coat, but as a fibrous structure applied upon the primary membrane, as in spiral-fibrous cells; and in wood-cells they are formed one within another to such a thickness that the cell-wall loses its original membranous character, and becomes a solid case, with the internal cavity reduced to a comparatively small chamber in the centre.

The simplest condition of a thickened cell-wall, is that met with in the unicellular and filamentous Algæ, where the primary membrane becomes coated in the interior by successive continuous layers of cellulose exactly resembling itself, and which often indeed can only be known to exist by comparing the thickness of old and young cells, since no lamellation can be detected; generally speaking, however, the action of moderately diluted sulphuric acid swells up such membranes, and renders the lamellæ more or less distinct (Pl. 47. fig. 24). The thickening layers of the unicellular and filamentous Algæ are scarcely to be compared with those of the cells of higher plants, since they are rather to be regarded as the primary membranes of new cells produced in the interior of the older cells, in many cases set free by the solution of the latter. These cell-walls sometimes exhibit peculiar fibrous appearances. See SPIRAL STRUCTURES.

These layers may be coloured blue by

sulphuric acid and iodine; when very young, even by iodine alone; but when old or where they undergo spontaneous solution into a kind of jelly, as in filamentous Algæ, this cellulose reaction seems to fail—at all events it is so uncertain in its behaviour, that, although it gives a positive result in successful cases, a negative result is altogether inconclusive.

In the cells of the generality of plants of higher organization, the secondary cell-membranes exhibit a striking difference from the primary, inasmuch as we find them constantly perforated by holes, slits, or orifices of some shape, so as to leave the primary membrane bare; whence results a spotted or streaked appearance of the cell-wall, as may be seen even in cells with the walls still very thin, such as fully-formed pith-cells of the Elder.

The earlier vegetable anatomists regarded these spots or dots as orifices through the cell-wall; but they are in reality only *pits* opening into the cavity of the cell, and closed externally by the original membrane of the cell. When the cell-wall becomes much thickened, as in cells of horny albumen or wood-cells, the layers successively deposited over the inside mostly correspond pretty exactly with the earliest layers, and leave the spots always free, so that these become gradually converted into tubular canals running through the thick cell-walls (Pl. 47. figs. 21–23 and 27). In the majority of cases, but not in all, the spots or pits in the cell-wall are opposite to similar spots in the walls of the adjacent cells, so that the cavities of the two contiguous cells are only separated from each other by the primary membrane of each, as at first, allowing free permeation of fluid from one to the other. In old cells these primary membranes become destroyed, and thus the cavities communicate freely through these canals running out through their hard thickened walls. The various complications of these pits are spoken of under the head of PITTED CELLS.

The secondary layers are further distinguished from the primary membrane by the prevalence of a tendency to assume the character of spiral bands or fibres winding upon the original cell-wall. This may be detected even in many cells which remain quite membranous, as in some *Confervæ* and many hairs, also in pitted lignified cells, where the thickening layer forms a general coat upon the inside of the cell; the liber-cells of many plants exhibit a delicate spiral striation of their walls, while some liber-cells display it with especial distinctness. Some of these cells give way in a spiral direction when torn by pulling lengthwise. In parenchymatous cells this spiral structure is often very fully developed in all its varieties; but it is especially characteristic of the vessels and ducts; while in certain woods, as in TAXUS, we have a combination of the porous with the spiral secondary deposits, the earlier thickening layers leaving spots uncovered while the latter ones are deposited along a spiral line coiling up the cell-wall from bottom to top, and thus the cell appears to have a spiral fibre lying upon its walls. These structures are spoken of at length under the heads of SPIRAL DEPOSITS and PITTED CELLS.

Cellulose is distinguished, when in the form of membrane or fibrous structure, by the blue colour it usually assumes when treated with iodine (starch differs in its granular form and its solubility in acids and potash, and its swelling up in hot water). The nitrogenous protoplasm is always coloured yellow-brown by iodine. The blue colour appears in many membranous parenchymatous tissues when the cells are soaked in tincture of iodine, dried, and then wetted with water. In other cases it is necessary to apply dilute sulphuric acid and solution of iodine simultaneously. It is sometimes difficult to bring out the blue reaction in old cells; various methods are had recourse to for this purpose. In corky or other epidermal tissues, the blue colour of cellulose may be brought out by soaking the cells for twenty-four hours or more in strong solution of potash, washing it well, soaking in tincture of iodine, drying, and then wetting with water. Old wood-cells undergo the same change by boiling in nitric acid, instead of treating with caustic potash, and then adding the iodine, &c. as above. All the solid structures of cell-membranes yield to one or other of these means, and exhibit the blue colour with iodine, which, if not indicative of a composition of cellulose, points to a substance intermediate between this and starch, produced out of the cellulose by the chemical action. The most characteristic property of cellulose, however, is its solubility in ammoniuret of copper (CELLULOSE.) The cells of Fungi and many Lichens and Algæ do not exhibit the ordinary reactions of cellulose, becoming brown instead of blue with iodine and sul-

phuric acid, and they are moreover not dissolved by ammoniuret of copper; while certain cell-walls of Lichens are coloured blue by iodine alone, from the presence of granulose. Cell-membranes and their modifications are examined, of course, in similar preparations to those mentioned as displaying the forms &c. of cells.

Further information will be given in the articles relating to the structures into the composition of which the cells enter.

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CELL-CONTENTS.—This term corresponds, in regard to vegetables, to the word *endochrome* as used by Thwaites, Ralfs, and some of the French botanists. It refers here most essentially to the protoplasm or primordial utricle, as this is the part effective in development; while the substances imbedded in or lying in the cavity of this are variable according to age, stage of development, &c. See Primordial utricle.

CELLA'RIA = Salicornaria.

CELLE'PORA, Fabr.—A genus of Infundibulate Polyzoa, of the suborder Cheilostomata, and family Celleporidæ.

Distinguished by the massive, globose, and incrusting, or erect and branched, calcareous polypidom, and the irregularly heaped vasiform cells, vertical to the common plane, with a beak on one or both sides, furnished with an avicularium. Seven British species.

C. pumicosa. Rough, porous, massive; cells suborbicular, the mouth round. Common.

C. vitrina. Incrusting; cells ovoid, very small, pearly, and irregularly arranged.

Bibl. Johnston, *Brit. Zooph.* 295; Gosse, *Mar. Zool.* 17; Busk, *Polyz.* ii. 85; *Paleont. Soc.* (*foss.*) 1859; Hincks, *Polyzoa*, 398.

CELLEPOREL'LA, Gray.—A genus of Infundibulate Polyzoa, of the suborder Cheilostomata, and family Porinidæ.

Two species.

Bibl. Hincks, *Polyzoa*, 413.

CELLEPO'RIDÆ.—A family of Infundibulate Polyzoa (Bryozoa), of the suborder Cheilostomata.

Char. Those of the single genus *Cellepora.*

CELLULAR TISSUE, of Animals. See Connective Tissue.

CELLULAR TISSUE, of Plants. See Tissues, Vegetable.

CELLULA'RIA, Pallas.—A genus of Infundibulate Polyzoa (Bryozoa), of the suborder Cheilostomata, and family Cellulariidæ.

Distinguished by the jointed, branched, erect polypidom, with flat, linear branches; the contiguous cells in two or three rows, perforated behind, and more than four between two joints; and the absence of avicularia and vibracula. One British species:

C. Peachii (*Cellularia Peachii*, var., Johnston). Cells narrowed downwards, truncate and somewhat rounded above; usually a small spine at the upper and outer angle; three to five perforations behind; orifice oval, regular; margin somewhat thickened, minutely granular; ovicell globular with a tessellated surface. On stones &c. from deep water.

C. ciliata (Johnston) = *Bicellaria cil.*; *C. avicularia* = *Bugula avic.*; *C. ternata* = *Menipea tern.*; *C. scruposa* = *Scrupocellaria scrup.*; *C. reptans* = *Canda rept.*; *C. Hookeri* = *Caberea Hook.*; *C. neritina* = *Bugula ner.*; *C. plumosa* = *Bugula plum.*

Bibl. Busk, *Mar. Polyz.* 20; id. *Ann. Nat. H.* 1851, vii. 82; Hincks, *Polyz.* 33.

CELLULA'RIIDÆ.—A family of Infundibulate Polyzoa (Bryozoa), of the suborder Cheilostomata.

Distinguished by the branched, erect polypidom, and the flat, linear branches, with the cells in one plane. Genera:

Cellularia. Cells in two or three rows, contiguous, perforated behind, more than four between two joints; no avicularia nor vibracula.

Menipea. Cells oblong, narrowed downwards, not perforate; one or two avicularia below the orifice in front.

Scrupocellaria. Cells with a vibraculum

behind, and a sessile avicularium at the upper and outer angle; orifice spinous.

Canda. Cells with a vibraculum in a notch on the outer side; no avicularium at the upper angle.

BIBL. That of the genera.

CEL'LULOSE.—The proximate principle of which the permanent cell-membranes of plants are always composed; it occurs also in some structures of certain animals, as the mantle of the Tunicata, the skin of the silkworm, the elytra of some insects, the tegument of some Crustacea, &c. In plants, its physical characters differ very much in different cases; sometimes it is exceedingly soft, and at once acquires a blue colour with iodine (amyloid?). Usually it becomes blue when soaked in tincture of iodine, dried, and then wetted with water. In other cases it is more dense, and does not become coloured blue with iodine until after treatment with sulphuric acid, when it becomes more or less bright blue (the ordinary test for cellulose). Occasionally this reaction gives a purplish colour. In old, infiltrated, or greatly consolidated cellulose structure, this test gives only a yellow-brown colour; but boiling in nitric acid (for woody tissues) or solution of potash (for epidermal tissues) will generally bring the cellulose into a state in which, if wetted with tincture of iodine, dried, and then wetted with water, it turns blue. The blue colour is produced in some resisting kinds of cellulose by a solution of iodine in chloride of zinc or by iodide of zinc. (SCHULZE'S TEST.) Sulphuric acid swells and dissolves cellulose; solutions of potash and nitric acid do not act so quickly, especially the latter. But the best test for ordinary cellulose is the ammoniuret of copper, which quickly dissolves it. Care must be taken in testing for cellulose with iodine, that no extraneous matter lodges on the preparation; fragments of cotton, blotting-paper, &c., consisting of cellulose, might give rise to error. Minute crystals of iodine precipitated from the tincture will give the object a bluish tint.

In the Tunicata, the intercellular substance consists of the cellulose, not the cells (*Schacht*).

BIBL. See AMYLOID and CELL-MEMBRANES. Schacht, *Müll. Archiv*, 1851 (*Qu. Mic. Jn.* 1852, pp. 34 and 106); Huxley, *Qu. Mic. Jn.* 1852, p. 22; Schmidt (Taylor's *Scient. Mem.* v. p. 1); Kölliker and Löwig, *Ann. Sc. N.* Zool. 1846, p. 193; Virchow, *Compt. Rend.* 1853 (*Ann. N. H.* xii. p. 482); Schweitzer, *Chem. Gaz.* xvi. 66, 336; Gmelin, *Handb. d. Chem.* vii. 574; Hancock, *Linn. Proc.* 1867.

CEMENTS.—These are used for closing the cells in which microscopic objects are placed for preservation; also for fastening pieces of glass to each other, to form cells, &c. Those, the method of making which we have not described, can be procured at any oil-shop.

Asphalt-varnish consists of a solution of asphalt (must be real) in boiling linseed-oil, or oil of turpentine, or in a mixture of the two; it should be creamy.

Black Japan consists of asphalt, gum anime, amber, linseed-oil, and oil of turpentine.

Brunswick black consists of asphalt, drying linseed-oil, and oil of turpentine.

Asphalt dissolved in benzole.

Canada balsam: *a.* alone; *b.* digested with sufficient ether, benzole, or chloroform, to render it slightly more fluid.

Electrical cement: *a.* is made by melting together 5 parts of rosin, 1 part of bees'-wax, and 1 of red ochre. *b.* The addition of 2 parts of Canada balsam renders this cement much more strongly adhesive to glass.

Gold-size may be prepared by boiling 25 parts of linseed-oil for three hours with 1 part of red lead and ½ of a part of umber; then pour off. Successive portions of a finely powdered mixture of equal parts of white lead and yellow ochre are then added to the oil, being well rubbed and mixed with it, until a tolerably thick liquid is formed; this must be once more thoroughly boiled. It is also sold.

Dammara-resin, is often used, dissolved in benzole; a third of gold-size is an advantage.

Gutta-percha cement is made by adding 15 parts of oil of turpentine to 1 part of finely cut-up gutta percha, and dissolving by the aid of a continued heat and stirring. The solution is then strained through a cloth. In the strained solution, 1 part of shell-lac is then dissolved by heat and stirring. The application of the heat is continued until a drop of the solution let fall upon a cold surface becomes nearly hard. It can be rendered thinner by the addition of more oil of turpentine.

Marine glue consists of caoutchouc and shell-lac dissolved in coal-naphtha by the aid of heat. It is sold by microscope-makers and those who mount objects.

Sealing-wax varnish. Prepared by adding enough spirit of wine to cover coarsely-powdered sealing-wax, and digesting at a gentle heat.

Shell-lac varnish. Prepared in the same manner as sealing-wax varnish, shell-lac being substituted for the sealing-wax. 20 drops of castor-oil to the ounce is an improvement.

White hard varnish consists of gum sandarac dissolved in spirit of wine, and mixed with turpentine varnish.

Bismuth-cement. Made by thickening a solution of mastic in chloroform with subnitrate of bismuth.

India-rubber and *asphalt.* Made with India-rubber 30 grs., asphalt 4 oz., mineral naphtha 10 oz. Dissolve the caoutchouc in the naphtha, then add the asphalt, and heat if necessary.

White lead mixed with drying linseed-oil, and oil of turpentine (white paint).

Wheat-paste should have a few drops of some volatile oil, or carbolic acid added to it.

Gum-arabic dissolved in water, with a small quantity of glycerine, and a few drops of volatile oil.

Zinc-cement. This is made with oxide of zinc, drying oil, Dammara-resin, and benzoline.

French cement, is made by melting India-rubber scraps in a covered iron pot. When quite liquid, lime previously slaked by exposure to the air and in fine powder, is added in small quantities at a time. When moderately thick, it is removed from the fire, well beaten in a mortar, and moulded in the hands until of the consistence of putty. It is useful for mounting large microscopic preparations &c. A drawn-out thread of this is pressed upon the top of the cell; the object and liquid are then added, and the cover pressed upon the cement, beginning at one side, so that the superfluous liquid may escape.

A number of other cements, applicable to various purposes, are described by Beale in How to Work &c. p. 54. The method of using these cements is treated of under PRESERVATION.

The varnishes should be kept in wide-mouthed capped bottles, or in bottles accurately closed by a cork, in the under part of which a camel's hair pencil is inserted.

A black colour may be imparted to any of the varnishes, by mixing them with lamp-black; or any colour, by adding correspondingly coloured sealing-wax.

They should all be old, or kept some time before use.

CENAN'GIUM, Fries. — A genus of Phacidiacei (Ascomycetous Fungi) growing upon dead twigs, bursting through the bark in the form of little cups or hollow papillæ. Tulasne has recently made some interesting observations upon this genus, and shown that the plants present two or even three kinds of reproductive bodies, *asci* with *spores,* and also *spermogonia* and *pycnidia* with *spermatia* and *stylospores.* In *C. Cerasi,* Fr., the pycnidia are minute tubular bodies upon the same stroma as the young cupules or asciferous cups. They have been described as species of *Sphæria* and as imperfect cupules of *C. Cerasi*; but their walls are lined with basidia, producing short-stalked stylospores, which are linear and flexuous, and very large, viz. about 1-500″ long; they exhibit three transverse septa. In this species the pycnidia are found in groups, and sometimes become confluent. In *C. Fraxini,* Tul. (Pl. 26. fig. 17), the pycnidia contain not only stylospores at the base of the cavity, but around the upper part are found spermatia seated on branched articulated filaments. These organs, however, are not regularly coexistent, but occasionally occur alone in a pycnidium; and sometimes the spermatia occur even in the asciferous cupules. The asci in the cupules of *C. Frangulæ* line the bottom of the cups, and are mixed with paraphyses; each ascus or theca contains four spores. Several other species are common in Britain.

BIBL. Berk. *Hook. Br. Fl.* ii. pt. 2, 211; *Ann. N. H.* vi. 359, 2 ser. vii. 185; Tulasne, *Ann. Sc. Nat.* 3 sér. xx. 133, pl. 16.

CENOMY'CE. See CLADONIA.

CENTROP'AGES, Kröyer.—A genus of Copepodous Entomostraca.

C. typicus; brown; North Sea.

C. hamatus; marine.

BIBL. Brady, *Copepoda* (*Ray Soc.*), i. p. 64.

CEPHALOP'ODA.—An order of Mollusca, containing the Nautilus, the Argonaut, the Octopus, the Cuttle-fish (*Sepia*), &c., with the fossil Belemnites and Ammonites. The cartilage of the cuttle-fish is noticed under CARTILAGE; the dorsal plate or sepiostaire under SHELL.

The chromatophores, or cutaneous pig-

ment-cells, and the cutaneous connective tissue are interesting structures.

CEPHALOSIPHON.—A doubtful genus of Rotatoria.

C. limnias. On *Ceratophyllum.*

Bibl. Pritchard, *Infus.* p. 670; Hudson, *M. M. Jn.* 1875, xiv. p. 165.

CEPHALOTHAMNIUM, Stein. — A genus of Flagellate Infusoria.

Char. Those of *Anthophysa*, but the pedicle stiff, hyaline, and homogeneous; filaments two.

C. cæspitosa. Pedicle short; attached to *Cyclops. C. cuneatum*, pedicle long; also on *Cyclops.*

Bibl. Kent, *Inf.* p. 272.

CEPHALOTRICHUM, Fr.—A genus of Dematiei (Hyphomycetous Fungi).

C. curtum is an extremely minute plant growing upon the leaves of Sedges; with scattered, short, brown, erect filaments, bearing somewhat globular heads composed of tufts of forked or ternate branches, with one or two short acute branchlets, slightly scabrous, bearing smooth spores.

Bibl. Berkeley, *Ann. N. H.* vi. p. 432, pl. 12. fig. 13; Corda, *Ic. Fung.* i. pl. 5. figs. 253–4.

CEPHEUS, Koch.—A genus of Oribatea (Acarina).

Char. Cephalothorax with lamellar appendages; tectum attached to cephalothorax by its base only; claws 3, alike.

C. vulgaris. Common near Paris.

Bibl. Nicolet, *Oribatea* (*Monograph*); Murray, *Ec. Entom.* 221; Michael, *Tr. Mic. Soc.* 1880, 177.

CERAMBYX, Linn. — A genus of Pseudotetramerous Longicorn Coleoptera.

C. (*Astynomus*) *ædilis* (fig. 367). Found on old timber.

CERAMIACEÆ.—A family of Florideous Algæ. Rose-red or purple sea-weeds, one freshwater, with a filiform frond, consisting of an articulated, branching filament, composed of a single string of cells, sometimes coated with a stratum of small cells. *Fructification*: 1. *favellæ*; berry-like receptacles, with a membranous coat, containing numerous angular spores; 2. *tetraspores*, attached to the ramuli or more or less immersed in the substance of the branches, scattered; 3. *antheridia*, produced in the same situations as the spores. British genera:

Ptilota. *Frond* compressed, inarticulate, distichous, pectinato-pinnate. *Favellæ* pedunculate, involucrate.

Microcladia. *Frond* filiform, inarticulate, dichotomous. *Favellæ* sessile, involucrate.

Ceramium. *Frond* filiform, articulate, dichotomous; the joints opaque. *Favellæ* sessile, mostly involucrate. *Tetraspores* mostly immersed.

Spyridia. *Frond* filiform, inarticulate; the branches clothed with minute setiform, articulated ramelli. *Favellæ* pedunculate, involucrate. *Tetraspores* sessile on the ramelli.

Griffithsia. *Frond* articulated, dichotomous, or clothed with whorled, dichotomous ramelli, rose-red. *Favellæ* involucrate, sessile or pedunculate. *Tetraspores* sessile, on whorled ramelli.

Wrangelia. *Frond* articulated, pinnate. *Favellæ* terminal, involucrate, containing tufts of pear-shaped spores. *Tetraspores* sessile, scattered on the ramelli.

Seirospora. *Frond* articulated. *Tetraspores* arranged in terminal, moniliform strings.

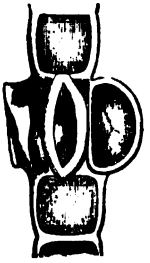
Callithamnion. *Frond*, at least the branches and ramuli, articulated, mostly pinnate. *Favellæ* terminal or lateral, sessile, without involucre (except in *C. Turneri*). *Tetraspores* sessile or pedicellate, scattered.

Chantransia. Freshwater; *fronds* filamentous, articulate, branched, cells in single series; *favellæ* in terminal corymbs.

Bibl. Harvey, *Man. Br. Algæ*; Cramer, *Ceram.* 1863; Sachs, *Bot.* p. 393. See also the Genera.

CERAMIUM, Roth.—A genus of Ceramiaceæ (Florideous Algæ), containing a number of species, mostly growing between tide-marks, of which *C. ciliatum* is noted as a beautiful object under a low magnifying power. The tetraspores are often only triple, and arranged tetrahedrally and not in a row (fig. 114).

Fig. 114.



Ceramium Deslongchampsii.
Fragment of a frond showing one tetraspore *in situ*, and two empty parent-cells. Magnified 50 diameters.

Bibl. Harvey, *Mar. Algæ*, pl. 22 C; *Phyc. Br.* pls. 139–41, &c.

CERATAULUS, Ehr.—A genus of Diatomaceæ.

Char. Frustules binate or concatenate, septate; valves turgid, suborbicular or broadly ovoid, with 2 tubular processes alternating with 2 spines. Marine and fossil.

C. turgidus = *Biddulphia turgida*; *C. Smithii* = *Eupodiscus radiatus*; *C. lævis* = *Biddulphia levis*; *C. thermalis*.

Bibl. Ehrenberg, *Ber.*; *Berl. Ak.* 1843, 270; Rabenhorst, *Fl. Alg.* i. 313.

CERATID'IUM. Ehr.—A genus of Infusoria, of the family Oxytrichina.

Char. Furnished with cilia, horns on the fore part of the body, but neither hooks nor styles.

One species, *C. cuneatum*. Dujardin considers this to have been a mutilated *Oxytricha*. The appearance of horns arises from the anterior part of the body being deeply notched.

Bibl. Ehr. *Infus.*; Dujardin, *Inf.* 421.

CERA'TIUM.—A genus of Isariacei (Hyphomycetous Fungi) containing a generally diffused British plant, *C. hydnoides*, which grows on rotten wood as a tuft of white simple or slightly branched oblong processes, which produce on their surface sterigmata (spicules, *Berk.*), each of which is surmounted by a spore which easily falls off. The whole plant readily collapses into a mucilaginous mass. The cellular appearance figured by Greville depends on the collapsing of the processes.

Bibl. Berk. *Hook. Br. Fl.* ii. pt. 2. 329; Grev. *Crypt. Fl.* pl. 168.

CERA'TIUM, Schrank.—A genus of Cilio-flagellate Infusoria = *Peridinia* with horns.

CERATOCLA'DIUM, Corda.—A genus of Hyphomycetous Fungi; consisting of a single species, *C. microspermum* (fig. 349), characterized by the erect, septate horny threads, clothed with a pallid stratum bearing simple sporophores (basidia), terminated by a single staff-shaped spore.

Bibl. Corda, *Prachtfl.* pl. 20.

CER'ATODON, Bridel.—A genus of Pottiaceous Mosses.

C. purpureus, very common on banks and walls, seta purple-red; *C. cylindricus*, seta pale.

Bibl. Wilson, *Bryolog. Br.* 83; Berkeley, *Brit. Moss.* 274.

CERATONE'IS, Ehr.—A genus of Diatomaceæ.

Char. Frustules cymbiform, free, with a more or less distinct central nodule, the apices rostriform and produced.

Smith places the British species in other genera, thus:

C. arcus = *Eunotia arcus*; *C. closterium* = *Nitzschia cl.*; *C. fasciola* = *Pleurosigma fasc.*; *C. gracilis* = *Nitzschia tænia*; *C. longissima* = *Nitzschia birostrata*.

Rabenhorst admits *C. arcus*, *C. amphioxys*, and *C. toxon* (Perty).

Bibl. Ehr. *Ber. d. Berl. Ak.* 1839, 1840 *et seq.*; Kutz. *Bacill.* and *Sp. Alg.*; Smith, *Br. Diat.*; Rabenhorst, *Fl. Alg.* i. p. 76; Perty, *Lebensf.* p. 205.

CERATO'NIA, Linn.—A genus of Leguminosæ (Flowering Plants). The pods and seeds or beans of *C. siliqua*—the Carob- or Locust-tree of Spain, are used for adulterating coffee. Pl. 2. fig. 8, *a*, *b*, represent the characteristic tissues of the pod; *e* and *d*, those of the bean.

CERATOP'TERIS, Brongniart.—A genus of Pterideæ (Polypodiaceous Ferns). Exotic. The inrolled margin of the leaf simulates an indusium.

C. thalictroides; tropics (figs. 226–7 thecæ, 228–30 spores).

Bibl. Hook, *Fil. Syn.* p. 174.

CERCA'RIA, Müll.—These organisms were formerly regarded as constituting a genus of Infusoria, but are now known to consist of the larvæ or nurses of Trematoda, as *Distoma*, &c.

The body is oblong, depressed, changeable; the mouth subterminal, armed or unarmed. Acetabulum subcentral. Tail filiform, simple, attenuate at the apex, deciduous.

They are found parasitically on the body, or within the intestines, liver, ovaries, &c. of Mollusca (*Lymnæus*, *Planorbis*, &c.); and may be obtained by wounding the body in water.

C. furcata (Pl. 51. fig. 32). On *Lymnæus stagnalis*, in autumn; length 1-12″. *C. helicis viviparæ*, in the liver of *Paludina vivipara*. *C. planorbis*, in the ovaries of *Planorbis corneus* and *marginatus*.

Diesing describes 12 "species." See Distoma.

CERCO'MONAS, Duj.—A genus of Flagellate Infusoria.

Char. Free, body rounded, discoidal or oblong, sometimes tuberculated, with a variable posterior prolongation in the form of a tail, which is longer or shorter and more or less filiform (Pl. 30. figs. 22, 23).

Dujardin remarks that the only absolute difference between the Cercomonads and the Monads consists in the presence of the posterior prolongation, which is formed by the substance of the body becoming agglutinated to the slide, and more or less drawn out so as to form sometimes merely a tubercle, at others an elongated tail, or a filament

almost as slender as the anterior filament and susceptible of an oscillating motion; also that he thinks he has frequently seen Monads gradually pass into the state of Cercomonads. See Bodo.

Found in infusions, pool-waters, &c.

C. acuminata (Pl. 30. fig. 22). *C. crassicauda* (Pl. 30. fig. 23). *C. intestinalis*, in typhoid diarrhœa, cholera; other species, many doubtful.

Dallinger and Drysdale describe in a species of *Cercomonas* (*C. typicus*, Kent), found in cod-macerations 2–3 months old, reproduction by transverse fission; also by conjugation—the individuals becoming amœboid, fusing together, and forming a smooth cyst, from which myriads of almost imperceptible germs are subsequently liberated.

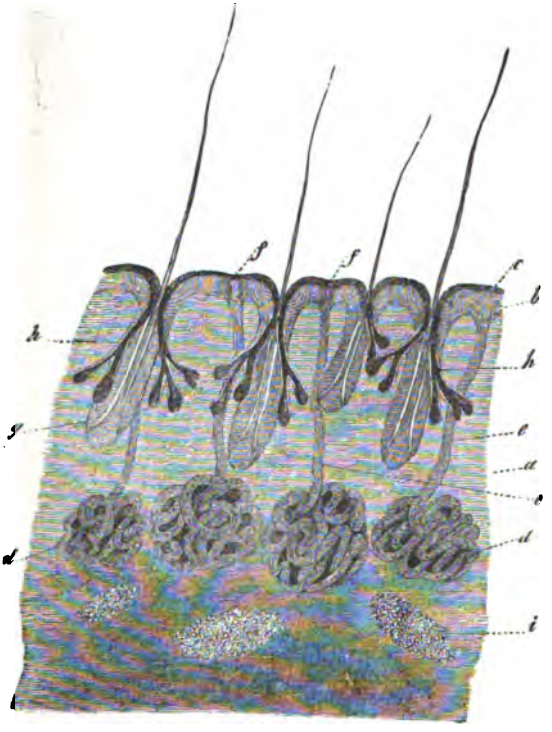
Bibl. Duj. *Infus.* 287; Pritchard, *Inf.* 497; Perty, *Z. Kennt.* 171; Kent, *Inf.* 258; Dallinger and Drysdale, *M. M. Jn.* 1873, x. 53, 245.

CEREUS. See Cactaceæ.

CERU'MEN.—The so-called 'wax' of the ear.

Its morphological elements are:—1. Hairs; these exhibit very beautifully the external layer of epidermic scales. 2. Occasionally, the *Demodex folliculorum*. 3. Numerous epidermic scales, mostly compressed, shrunk, or so altered as to resemble fibres, but resolvable into their original form by warming with solution of potash and the subsequent addition of water; by this treatment they are frequently rendered brown, purplish, or almost black. 4. Very numerous cells, filled with pale fatty matter, of a rounded or elongate, flattened, or irregular form; these are derived from the sebaceous follicles. 5. Numerous free oil-globules of the most varied sizes. 6. Yellow or brown granules, and aggregations of them, mostly free, sometimes contained in cells. 7. Various elements derived from without, as fibres of cotton, linen, &c. The deafness of old persons usually arises from an accumulation of indurated cerumen. See Ceruminous Glands.

Fig. 115.



Magnified 20 diameters.

Perpendicular section of the meatus auditorius externus. *a*. Corium; *b*, rete mucosum; *c*, epidermis; *d*, ceruminous glands; *e*. their ducts; *f*, their terminal orifices; *g*, hair-follicle; *h*, sebaceous follicles; *i*, fatty tissue.

CERU'MINOUS GLANDS.—The glands which secrete the 'wax' of the ear. They are situated in the tube of the ear, or the meatus auditorius externus of anatomists. They closely resemble the sudoriparous ducts in appearance, and exist only in the cartilaginous portion of the passage, where they are situated between the skin and the cartilage, or the fibrous mass which occupies its place. Each consists of a simple tube coiled at one end, so as to form a gland (fig. 115 *d*), the other being continued in the form of a duct (fig. 115 *e*) to the surface of the skin, upon which it opens; occasionally, however, into the upper part of the hair-follicle.

The glands consist of an ex-

ternal coat of connective tissue, with scattered, somewhat spindle-shaped nuclei, and very fine nuclear fibres; a layer of smooth, longitudinal, muscular fibres, consisting of short fibre-cells with elongated nuclei; and an inner single layer of epithelium, composed of polygonal cells, from 1-1800 to 1-1100″ in diameter, with roundish nuclei. These cells contain round or irregularly-shaped yellowish-brown granules, of very various sizes, as also globules of oil. The duct has a coat of connective tissue, and an epithelial coat, consisting of several layers of small nucleated cells, not containing fat or pigment-granules.

CERVIN'IA, Norman. — A genus of marine Copepodous Entomostraca.

C. Bradyi. Oban.

Bibl. Brady, *Copepoda* (*Ray Soc.*), i. 85.

CESTODISCUS, Grev.—Frustules disk-shaped, circular or oval; valves with radiating granules, and a submarginal circle of obtuse processes unconnected by special radiating lines of dots with the centre. 4 species.

Bibl. Greville, *Mic. Trans.* 1865, 48; 1866, 123.

CETERACH, Willd.—A genus of Ferns, usually arranged with the Asplenieæ, although there is only a rudimentary indusium, the place of this being supplied by scales. *C. officinarum* (*Asplenium Ceterach*), the native species, occurs chiefly in limestone districts.

CETOCHILUS.—A genus of Entomostraca (Crustacea), belonging to the order Copepopa, and family Cetochilidæ.

Distinguished by the two small styliform appendages to the head; the two-branched inferior antennæ, the branches nearly equal; the unbranched jaw-feet; the six-jointed thorax, and four-jointed abdomen; and the last pair of legs being formed like the rest. Marine. *C. septentrionalis*; bright red; forms part of the food of the whale and various fishes; length 1-10″.

Bibl. Baird, *Brit. Entomos.* p. 233; Grobben, *Claus's Arb.* 1880, 243, iii. (*Jn. Mic. Soc.* 1881, i. 734).

CETRA'RIA, Ach.—A genus of Lichens: tribe Cetrarici.

Char. Thallus bright brown, rigid, erect, or ascending, divided into laciniæ, with shining cortical layer. Apothecia dull or bright brown. Spermatia cylindrical.

3 British sp.: *C. islandica*, the well-known Iceland Moss; *C. Delisei*; and *C. aculeata.*

Bibl. Nylander, *Syn.* 298; Leighton, *Lichen-Flora*, 1879, 91.

CETRARIE'I. — A tribe of Lichens; family Lichenacei.

Char. Thallus compressed, fruticulose, or membranously dilated; apothecia marginal; spores 8, small, colourless, simple.

Genera: *Cetraria* and *Platysma.*

CEUTHOS'PORA, Fr.—A genus of Melanconiei (Stylosporous Fungi) closely related to *Phoma*, one common species of which (*C. phacidioides*) grows on holly-leaves; another occurs on the Cherry-laurel (*C. Lauri*). It is probable that these are only forms belonging to some Ascomycetous genus.

C. phacidioides, Grev. 3–5 cells in the stroma, splitting into 3–5 plain short teeth.

C. Lauri, Sow. Unilocular, splitting into 3–4 acute teeth.

Bibl. Berk. *Hook. Br. Fl.* ii. pt. 2. p. 283; Grev. *Crypt. Fl.* pls. 253, 254.

CHÆTO'CEROS, Ehr.—A genus of Diatomaceæ.

Char. Frustules concatenate; valves equal, subcylindrical, with two processes, one on each side, which, in the young state, are very short and tubular, forming very long horns as the frustules become older; horns subsequently converted into very long, thin and interwoven siliceous filaments. Marine and fossil.

Somewhat allied to *Biddulphia.* Rabenhorst admits 18 species. *C. didymus* (Pl. 50. fig. 47). Some British.

Bibl. Ehrenb. *Ber. d. Berl. Ak.* 1844, 198; Kützing, *Sp. Aly.* 138; Brightwell, *Micr. Jn.* vi. 155; Lauder, *Mic. Tr.* 1864, 75; Rabenhorst, *Fl. Alg.* i. 321.

CHÆTOCOC'CUS, Ktz.—A doubtful genus of Algæ.

Char. Filaments rigid, short, spiniform, arising from a cellular substratum.

C. violaceus, radiate, green, becoming violet on drying, on *Rhizoclonium*; *C. hyalinus*, on *Cladophora.*

Bibl. Rabenhorst, *Flor. Alg.* ii. 199.

CHÆTODIS'CUS, Grev.—A genus of Diatomaceæ.

Char. Frustules disk-shaped; valves circular or oval, with radiating dots and a submarginal circle of obtuse processes unconnected by means of special radiating lines of dots with the centre.

4 species.

Bibl. Greville, *Mic. Tr.* 1865, p. 48; 1866, p. 123.

CHÆTOGLENA, Ehr.—A genus of Infusoria, of the family Peridinæa.

Char. Carapace hispid, or studded with

rigid spines; no transverse furrow; an eye-spot present; organ of motion a flagelliform filament.

C. Volvocina (Pl. 30. fig. 24 *a*). Oval, internal substance brownish-green; eye-spot red; length 1-1100″. Aquatic. This appears to be the same as *Trachelomonas Volvocina*. See TRACHELOMONAS.

C. caudata. Oval, hispid, with a short tail; internal substance green; eye-spot red; margin of carapace urceolate and toothed; length 1-850″; aquatic.

BIBL. Ehr. *Infus.*; id. *Ber. d. Berl. Ak.* 1840, 199; Dujardin, *Infus.* 239.

CHÆTO'MIUM, Kunze.—A genus of Perisporiacei (Ascomycetous Fungi), having a filamentous mycelium bearing superficial roundish or ovate conceptacles clothed with hairs, finally opening above and containing clavate asci with paraphyses; sporidia simple, ovate. The asci in this genus are very delicate and are readily absorbed, so that frequently there is not a trace of them, and the sporidia seem naked. British species:

C. elatum, Kunze. Conceptacles subovate, black or brown, more or less crustaceous; sporidia apiculate at each end. Greville, *Sc. Crypt. Fl.* pl. 230. On mouldering straw, old matting, &c. Very common.

C. chartarum, Ehr. Conceptacles subglobose, black, surrounded by a bright yellow spot; sporidia roundish. On paper.

C. glabrum, B. On damp straw.

BIBL. Hook. *Br. Fl.* ii. pt. 2. p. 328; Kunze, *Mycolog.* Heft i.; Fries, *Syst. Mycol.* iii. p. 254, 255.

CHÆ'TOMONAS, Ehr.—A genus of Infusoria, of the family Cyclidina.

Char. An oral vibratile organ (whether a flagelliform filament or ring of cilia is uncertain); movement of animal slow, but leaping effected by means of non-vibratile bristles situated upon the body.

In putrid animal and vegetable infusions; in dead bodies of other organisms—*Closteria*, &c.

C. globulus (Pl. 30. fig. 25 *a*). Nearly spherical, ash-coloured, setæ numerous; length 1-2700″.

C. constricta (Pl. 30. fig. 25 *b*). Oblong, constricted in the middle, hyaline, setæ two; length 1-5400″.

BIBL. Ehr. *Infus.* p. 248.

CHÆTOMORPHA, Kütz. = CONFERVÆ spec. (Rabenhorst, *Fl. Alg.* iii. p. 327).

CHÆTONO'TUS, Ehr.—A genus of microscopic aquatic animals, placed by Ehrenberg among the Rotatoria (Rotifera), and by Dujardin with the Infusoria.

Ehrenberg places it in the family ICHTHYDINA. Dujardin gives the following characters:

Body oblong, convex, and furnished with hairs or scales above; flat and provided with very minute vibratile cilia beneath; terminated in front by a rounded margin, near which is a distinct mouth; posteriorly bifurcate or terminated by two caudiform processes.

The three or four species are found in fresh water, amongst aquatic plants. Their structure requires further investigation.

Chætonotus larus (Pl. 31. fig. 24). Length 1-710 to 1-220″.

Dujardin appends *Ichthydium*, Ehr., to this genus.

BIBL. Ehr. *Infus.* 389; Duj. *Inf.* 568; Mecznikow, *Sieb. & Köll. Zeitsch.* 1865 (*Qu. Mic. Jn.* 1866, 240).

CHÆTO'PHORA, Schrank.—A genus of Chætophoraceæ (Confervoid Algæ), characterized like *Draparnaldia* by setigerous branched filaments, but differing from the latter by the filaments being imbedded in a gelatinous matrix. The *Chætophoræ* are found in fresh water, forming little green protuberances on stones, sticks, &c., usually bright green. The zoospores are formed singly in the joints, and bear four cilia. True fruit is figured by Berkeley in *C. pisiformis, Gleanings of Br. Alg.* pl. 1. fig. 1.

The membrane of the filaments is very delicate; and the zoospores appear sometimes to escape by its solution. British species:

C. endiviæfolia, Ag. Hassall, *Alg.* pl. 9. figs. 1, 2; Kütz. *Tab. Phyc.* iii. pl. 21. fig. 3. *Ulva incrassata, Eng. Bot.* 967. Common in streams.

C. tuberculosa, Hook. Hass. *l. c.* pl. 9. 7, 8; Kütz. *l. c.* pls. 19 and 21. *Rivularia tuberculosa, Eng. Bot.* 2366. Boggy pools.

C. elegans, Ag. Hass. *l. c.* pl. 9. 3, 4; Kütz. *l. c.* pl. 20. Stagnant pools; common.

C. pisiformis, Ag. Hass. *l. c.* pl. 9. 5, 6; Greville, *Crypt.* t. 150; Kütz. *l. c.* pl. 18; Thuret, *Ann. Sc. Nat.* 3 sér. xiv. pl. 19. figs. 1-3. Subalpine lakes.

C. dilatata, Hass. *l. c.* pl. 13. fig. 2.

C. longæva, Carm. A doubtful species. Hook. *Br. Fl.* ii. pt. 1.

Rabenhorst admits 10 species: *Fl. Alg.* iii. 383.

BIBL. As above.

CHÆTOPHORA'CEÆ.—A family of

Confervoid Algæ, growing in sea or fresh water, rarely terrestrial, invested with gelatine; either filiform, or (a number of filaments being connected together) expanded into gelatinous, branched, definitely-formed or shapeless masses or fronds. Filaments jointed, furnished with bristle-like processes. Fructification consisting of spores; and four-ciliated zoospores, formed out of the contents of the articulations.

Synopsis of British Genera.

Draparnaldia. Filaments free, gelatinous, the primary nearly colourless, bearing tufts of coloured ramuli at the joint; zoospores formed singly in the joints of the ramuli.

Chætophora. Filaments dichotomously branched, aggregated into shapeless, incrusting or branched, gelatinous fronds, the joints bearing bristle-like branches; zoospores solitary in the articulations; the membranes of the filaments very fugacious.

Coleochæte. Frond disk-shaped or irregularly expanded, adherent to leaves &c. of aquatic plants under water, formed of jointed dichotomous filaments radiating from a centre, more or less conjoined laterally; the joints producing from the back a slender truncate open tube, from which a long bristle is exserted. Fructification: spores and zoospores formed in the joints.

Ochlochæte. Frond discoid, appressed; filaments cylindrical, radiating from a centre, irregularly branched, consisting of a single series of cells, each of which is commonly prolonged above into an articulate bristle.

Foreign genus. See APHANOCHÆTE, Kütz.

BIBL. See the genera.

CHÆTOP'SIS, Grev.—A genus of Mucedines (Hyphomycetous Fungi) characterized by erect jointed threads, whorled below, above simple and flagelliform, bearing cylindrical spores from the tips of the branchlets. One species only is known, *C. Wauchii.*

BIBL. Grev. *Crypt. Fl.* pl. 236; Berkeley, *Br. Fung.* 353; Cooke, *Handbook*, 614.

CHÆTOSPI'RA, Lachmann.—A genus of Infusoria, of the family Bursarina.

Char. Buccal spire supported on a narrow band-like process, at the base of which is the mouth.

C. Mülleri. Shell lageniform, horny. On torn leaves of *Lemna trisulca.*

C. mucicola. Shell gelatinous. Among Algæ, fresh water.

BIBL. *Ann. N. H.* 1857, xix. pl. 9. figs. 6 and 7; Claparède and Lachmann, *Infus.* 216; Kent, *Infus.* 601.

CHÆTOSTRO'MA, Corda. See VOLUTELLA.

CHÆTOTYPH'LA, Ehr.—A genus of Infusoria, of the family Peridinæa.

Char. Carapace (siliceous?) hispid or covered with rigid hairs; no transverse furrow, no eye-spot.

C. armata (Pl. 30. fig. 26: *a*, side-view; *b*, posterior end view). Ovato-subglobose, rounded at each end, hispid with short setæ, posteriorly a ring of dark prickles; length 1-620″.

C. aspera (Pl. 30. fig. 26 *c*). Oblong, rounded at each end, hispid with short setæ; posterior prickles scattered without order; length 1-550″.

C.? pyritæ. Oblong cylindrical, ends rounded; setæ slender and elongate; no posterior prickles; length 1-1100″, breadth half the length. Fossil in flint. Ehrenberg questions whether this is not a Xanthidium.

BIBL. Ehr. *Infus.* 250; Duj. *Inf.* 328.

CHAITOPH'ORUS, Koch.—A genus of Aphidæ.

Char. Antennæ hirsute, 7-jointed; upper wings with a doubly forked cubitus; lower with two oblique veins; abdomen studded with tubercles tufted with bristles: dimorphous.

Several species; occurring upon the willow, poplar, birch, &c.

BIBL. Buckton, *Aphides* (*Ray Soc.*), ii. 120.

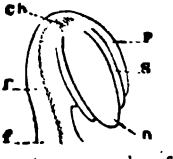
CHA'LARA.—A genus of Mucedines (Hyphomycetous Fungi); characterized by the erect jointed threads, which at their slender apices break up into cylindrical spores.

C. longipes has been found in this country.

BIBL. Sturm, *D. Fl.* 29, pl. 35; Saccardo, *Fasc.* i. pls. 29–35.

CHALA'ZA (in plants).—The term applied to the base of the nucleus of ovules,

Fig. 116.



Section of an anatropous ovule: *f*, funiculus; *r*, raphe; *ch*, chalaza; *p*, external coat of testa; *s*, internal coat or tegmen; *n*, nucleus.

where the substance of the former is con-

tinuous with the coats, and where the vascular cord derived from the placenta terminates (fig. 116, *ch*).

CHALCID'IDÆ.—A family of Entomophagous Terebrant Hymenoptera, distinguished by the following characters :—

Head transverse, with the eyes lateral and the face usually bisulcate for the reception of the base of the antennæ (Pl. 36. fig. 8). Antennæ short, frequently thickened at the tips, sometimes branched, composed of not more than thirteen joints, and almost always geniculated at the extremity of the elongated first joint. Palpi very short, sometimes branched. Thorax ovate, with a distinct collar. Wings nearly destitute of veins; the anterior with a rather strong subcostal vein running parallel to the anterior margin for about half the length of the wing, and terminating in a stigma, from which a short vein is given off obliquely towards the disk of the wing; the posterior sometimes veinless, sometimes with a short subcostal vein. Legs moderate; hinder thighs sometimes much thickened; tarsi of four or five joints. Abdomen generally composed of seven segments in the males and of six in the females, united to the thorax by a peduncle of variable length; ovipositor usually concealed entirely in a cleft of the lower surface of the abdomen, which extends nearly to the base (fig. 9), but sometimes exserted and very long. The structure of the ovipositor is the same as that of the *Ichneumonidæ*.

The larvæ, like those of the rest of the petiolated Hymenoptera, are footless fleshy grubs (fig. 10). Like the larvæ of the Ichneumonidæ, they usually live in the interior of other insects; but it is remarkable that those of a few species attach themselves to the skin of their victim, and in this position feed upon its substance. The internal feeders generally change to the pupa state within the pupa of the insect attacked by them; a few, however, break through the skin of the larva and attach themselves to it or to neighbouring objects by a glutinous secretion, or by a small silken cocoon. The pupæ have the limbs more closely attached to the body than in the other Hymenoptera; and in those which have an elongated ovipositor, that organ is turned up over the back. The pupæ are at first whitish, but afterwards become brown or black; they are usually naked (fig. 11).

The family Chalcididæ includes an immense number of parasitic Hymenoptera, the majority of which are of extremely minute size, and adorned with the most brilliant metallic colours. This circumstance, coupled with the delicacy of their form, renders many of the species most beautiful objects; and considering their interesting habits, they certainly do not deserve the almost total neglect which they have met with. The largest species belong to the genus *Leucopsis*; but none of these greatly exceed half an inch in length, and they are not found further north than the South of Europe. The thickened hinder thighs which occur in many species of this family, do not always indicate that the insects possessing them are endowed with saltatorial powers; on the other hand, many species which are destitute of thickened thighs leap well; and according to Westwood's observations, this is especially the case with those in which the intermediate tibiæ are furnished with a large spine at the extremity (*Encyrtus*, Pl. 36. fig. 12).

The perfect insects may be met with in abundance during the summer and autumn upon the leaves of trees and plants. They may be taken either by sweeping the herbage with a net, or by beating trees or hedges over a broad net or umbrella.

The sexes are often distinguished in this family by remarkable external characters, especially in the structure of the antennæ. These, in the males of many species, are beautifully branched, in consequence of the joints giving off processes from their sides; in *Eulophus* (fig. 13) we usually find three branches; and in some foreign genera recorded by Westwood the number is increased to five, seven, and even nine. A few species have the wings rudimentary or entirely wanting; and it is remarkable that in some cases the male only is deprived of wings, the female being well furnished with these organs.

The Chalcididæ are parasitic upon insects of nearly all orders, and deposit their eggs in them in all stages of their growth. Some of the minute species even find sufficient nourishment in the eggs of other insects; amongst these we may mention *Pteromalus ovulorum* as a common species, which has been reared from the eggs of Lepidopterous insects. From a single egg of this description, Fonscolombe obtained five or six individuals of a minute species, described by him under the name of *Pteromalus atomos*. Westwood also mentions the occurrence of two species of this family in the egg-cases

of species of *Mantis* from Brazil and the Isle of France; and Sells has recorded the occurrence of no less than ninety-four specimens of a small *Pteromalus* in a single egg-case of a *Blatta*.

Other minute species deposit their eggs in the bodies of *Aphides*; and their larvæ find a sufficient supply of nourishment even in such small insects as these. Some, especially those forming the genus *Coccophagus* of Westwood, attack the *Coccidæ*, of which they destroy great numbers.

Other species, including most of the larger forms, live parasitically in the cells of the solitary Bees and Wasps. Amongst these we may notice the singular genus *Monodontomerus*, one species of which, first discovered by Audouin, and described by Newport in the 'Linnean Transactions,' is found in the nests of *Odynerus*, *Anthophora*, and *Osmia*. The male of this remarkable insect has only rudimentary wings, so that it is unable to quit the cell of the Bee or Wasp in which it passed its earlier stages, whilst the female, being well provided with wings, can fly about, after impregnation, to seek other nests in which to deposit her eggs.

The species which are furnished with long ovipositors belong chiefly to the genus *Callimome* (fig. 14, *C. cynipis*); they deposit their eggs in different kinds of galls, the vegetable excrescences caused by the punctures of various other insects upon plants. The larvæ of these gallicolous Chacididæ devour the rightful occupant of the gall.

The instinct which prompts these insects to deposit their eggs in the larvæ of these gall-producing insects, is scarcely so astonishing as that by which others are impelled to insert theirs into the bodies of other parasitic insects, whilst still enclosed within the tissues of their victim. Some of these, such as *Chrysolampus suspensus* and *Coruna clavata*, attack the larvæ of the *Aphidii*, minute Ichneumons which infest the bodies of Aphides; and De Filippi has recorded the occurrence of the larvæ of one species within a small Dipterous larva which itself lives in the egg of *Rhynchites Betuleti* in the vineyards near Turin (Ann. N. H. 1852, ix. 461). De Filippi is inclined to regard the phenomena observed by him as an instance of alternation of generations; but they evidently constitute an example of double parasitism.

Bibl. Westwood, *Introd.* ii. & *Zool. Jn.*; Spinola, *Ann. Muséum*, xvii. 138–152; Nees von Esenbeck, *Hynenopt. Ichneum. Mon.* ii.; Boyer de Fonscolombe, *Mon. Chalc. Gallo-Provinciæ*, *Ann. Sci. Nat.* xxvi.; Walker, *Mon. Chalcid.*; Dalman and Boheman in *Kongl. Vet. Akad. Handlingar*; Walker, *Entom. Mag.* and *Ann. N. H.*; Guérin's *Mag. de Zool.*, *Ent. Mag.* &c., and Haliday, *Entom. Mag.*

CHÁ'LIMUS, Burm.—A genus of Crustacea, of the order Siphonostoma, and family Caligidæ.

Char. Fourth pair of legs slender, of only one branch, and serving for walking; frontal plate with a long and slender prehensile appendage arising from the middle of its anterior surface.

C. scombri. Found upon the mackerel, and upon species of *Caligus*, of which it has been supposed to be the young; length about 1-6".

Bibl. Burmeister, *N.A. Acad. N.C. Bonn*, xvii.; Baird, *Brit. Entomostr.* p. 278.

CHALK.—An earthy form of carbonate of lime, constituting strata of great thickness in England and several parts of Europe, &c. The application of the microscope to the examination of chalk brought to light the interesting fact that this substance has not had its origin in chemical precipitation, since it contains abundance of the inorganic remains of marine animals, and a few plants, perhaps doubtful.

Many of these relics are not microscopic, as those of Fishes and Reptiles, the shells of Malacostracous Crustacea, Mollusca, Echinodermata, the polypidoms of Zoophytes, &c.; hence their consideration does not come within our province: yet it must be remembered that their microscopic structure is characteristic, so that the class, order, or even the more minute division of the animal kingdom to which they belong may be discovered. See Bone and Shell.

The chief microscopic constituents of the calcareous formations examined by Ehrenberg, viz. chalk, and nummulitic and other compact limestones, were found to be shells of Foraminifera, spicules of sponges, and peculiar bodies called crystalloids; and several siliceo-calcareous earths he found to be wholly composed of spicules, Diatomaceæ, Polycystina, and Foraminifera.

The Foraminifera found by Ehrenberg in the Gravesend chalk were:—*Cristellaria cultrata*, *Globigerina cretacea*, *Heterostomella aculeata* and *tumens*, *Nodosaria ovicula*, *Planorbulina ammonoides*, *Polymorphina Thouini*, *Pulvinulina Micheliniana*, *Textularia agglutinans*, *gibbosa*, *globulosa*,

striata, and *subangulata*, *Vaginulina lævigata* and *longa*, *Verneuilina spinulosa*, and *Vulvulina pennatula*. D'Orbigny enumerated 22 species from the English chalk, including some of the above; many others have also been found.

The genera and subgenera in which they are grouped are—*Bolivina*, BULIMINA, CALCARINA, *Cristellaria*, *Dentalina*, *Flabellina*, *Frondicularia*, *Gaudryina*, GLOBIGERINA, *Haplophragmium*, *Heterostomella*, *Lingulina*, LAGENA, LITUOLA, *Marginulina*, MILIOLA, *Nodosaria*, NODOSARINA, *Planularia*, *Planulina*, PLANORBULINA, POLYMORPHINA, PULVINULINA, *Quinqueloculina*, *Ramulina*, ROTALIA, *Sagrina*, SPHÆROIDINA, TEXTULARIA, TINOPORUS, *Trilaxia*, TROCHAMMINA, *Truncatulina*, VALVULINA, *Verneuilina*, *Virgulina*, and *Webbina*.

Ehrenberg found two Diatomaceæ in the English chalk, viz. *Fragilaria capucina* (*F. rhabdosoma*), and *Fr. pinnata*, Ehr. (=*F. mutabilis*, Sm.). Some other Diatomaceæ referred by Ehrenberg to the chalk, belong to foreign chalk and to totally different beds.

The material of chalk comprises very minute, numerous, and remarkable bodies, called crystalloids and morpholites by Ehrenberg (Pl. 25. fig. 15). They are elliptical or rounded, and flattened, from 1-10,000 to 1-2500″ in length, the most numerous perhaps 1-3000″; some of them consist of a simple ring (*a*); in others this is marked with pretty regular transverse lines, so as to make it appear jointed (*b*); in others, again, there is a thinner central portion, often exhibiting one or more granules (*c*). Ehrenberg regarded these as arising from the disintegration of the microscopic organisms forming the chalk into much more minute calcareous particles, and their reunion into regular elliptical plates or disks by a peculiar process, differing essentially from, and coarser than that of crystallization, but comparable with it,—one probably preceding all *slow* crystalline formation, and causing, but not alone, the granular state of solid inorganic matter. These microscopic bodies have of late years been regarded as the agglomerated or separate plates of very simple protozoan organisms by Huxley, Wallich, and Sorby. By Carter they are believed to belong to an Alga (COCCOLITHS).

The best method of examining chalk for minute Foraminifera is this: place a drop of water upon a glass slide, and put into it as much finely scraped chalk as will cover the point of a pen-knife; then diffuse it through the water, and set it aside for a few seconds. Next remove the finest particles which are suspended in the water, together with most of the water, and allow the remainder to become perfectly dry. Moisten this remainder with oil of turpentine, and warm it over a spirit-lamp; then add Canada balsam, and digest it upon the brass table (INTR. xxviii), but without its frothing. A preparation thus made seldom fails; and when magnified 300 diameters, the mass is seen to be chiefly composed of minute well-preserved organisms. As thus prepared, the cells of the Foraminifera first appear black, with a white central spot (Pl. 24. fig. 3), which is caused by air-bubbles contained within the cells. The balsam gradually penetrates into the cells, the black rings of the air-bubbles disappear, and the minute, frequently very elegant cells of the Foraminifera become visible. See FLINT, and FORAMINIFERA.

The crystalloids are best examined in common whiting, or powdered chalk, which has been shaken with water and set aside. A very minute quantity removed with a dipping tube will exhibit them.

BIBL. The various works on geology, as those of Lyell and Ansted; Mantell, *Wonders*, *Medals of Creation*, and *Ann. N. H.* 1845, xvi. p. 73; Bowerbank, *Geol. Tr.* 2 s. vi.; Ehrenberg, *Abh. d. Berlin. Ak.* 1838 (*Ann. N. H.* 1841, vii.), and *Abh. d. Berl. Ak.* 1840 (Taylor's *Sc. Mem.* iii.), and *Mikrogeologie*, 1854; Parker and Jones's *Ehr. résumé*, *Ann. N. H.* 1872; Williamson, *Manchester Lit. Phil. Soc.* viii. 1847; Morris, *Cat. Br. Fossils*, 1854; D'Orbigny, *Mém. Soc. Géol. d. France*, iv. (Abs., *Ann. N. H.* 1841, vii. p. 390); Zirkel, *Mineralien &c.*, 1873, 303; Dixon's *Sussex*, 2 ed., 1878, 123 & 283.

CHALK-STONES. This term is vulgarly applied to the white concretions formed around the joints in chronic gout, or, as it is sometimes called, rheumatic gout. They consist of very minute needles of urate of soda (Pl. 12. fig 12 *b*).

CHAMÆNE'MA, Kütz.—A supposed genus of Leptotricheous Algæ, consisting of dusky-coloured jointed filaments, forming flocks in various syrups. Doubtless the mycelia of some Fungi, such as PENICILLIUM.

BIBL. Kützing, *Sp. Alg.* 158.

CHAMÆSI'PHON, Braun.—A genus of Oscillatoriaceæ (Confervoid Algæ).

Char. Trichomata erect, æruginous or

violet, parasitic, sheathed, articulate; terminal joints forming rounded gonidia. Four species.

C. confervicola (Pl. 3. fig. 6). On *Calothrix*, *Vaucheria*, &c.

BIBL. Rabenhorst, *Fl. Alg.* ii. 148 (figs.).

CHANTRAN'SIA, Fries. — A genus of Ceramiaceæ (Florideous Algæ).

Species numerous, purple, violet, or ferruginous. Found on stones, submerged mosses, and wood. Antheridia subglobose, terminal, tetraspores rare.

BIBL. Rabenhorst, *Fl. Alg.* iii. 401; Pringsheim, *Beit. z. Morph. d. Meeres-Algen*; Hassall, *Alg.* 75.

CHA'RA, L. See CHARACEÆ.

CHARA'CEÆ.—A family of plants generally classed among the Algæ, but which, from the character of their reproductive organs, perhaps demand a more elevated position. They may be placed on the boundary between the Algæ and the Hepaticæ. They are remarkable for their well-known 'circulation,' first discovered by Corti. The Characeæ are aquatic plants, of filamentous structure, exhibiting elongated axes furnished at intervals with whorls of branches (fig. 117); these are sometimes regarded as leaves. In some species this axis is a simple tube (fig. 124), sometimes a tube with a cortical layer of smaller tubes surrounding it (figs. 118, 119). Some authors have divided the species, on this and some other grounds, into two genera, *Nitella* (simple tubes) and *Chara* (corticated tubes); but according to Al. Braun, who has devoted great attention to this family, the characters will not hold. The mode of ramification of the simple tubes is seen in figs. 124 & 125; that of the compound axes is fundamentally the same, but other cells arise from the branch cells at the articulations, one above and one below each branch (*C. crinita*). Those on the upper side of the branches grow up over the central axis to meet those descending from the under side of the branches of the whorl next above, the ends becoming intercalated about the middle of the internode: in this course of growth, cell-division takes place, and the primary cortical tubes are not only made up of many lengths in each internode, but each is perpendicularly divided into two, one large and one smaller tube (*C. vulgaris*), or produces a secondary tube on each side (*C. aspera*); the primary tubes stand out as ribs from the surface. These cortical tubes describe a spiral course around the internode.

Fig. 117.

Fig. 118.

Fig. 120.

Fig. 119.

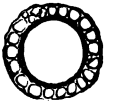


Fig. 117. Chara vulgaris. Natural size.
Fig. 118. Fragment of stem, magnified 15 diam., showing the cortical tubes.
Fig. 119. A section of ditto, magnified 30 diam.
Fig. 120. Branch with nucule and globule, 10 diam.

Filamentous radical cells are also produced from the whorls. The cells of the main axis and its branches, and the primary cortical cells, are those in which the circulation of the contents may be seen best. The cell-wall is lined by a close layer, like a

pavement, of chlorophyll-globules imbedded in colourless protoplasm, arranged in a somewhat spiral order; within them lies a thick layer of semigelatinous consistence (the circulating protoplasm); and the centre is filled up with a watery liquid. The circulation in the ordinary cells consists in the movement of the gelatinous protoplasmic sac, as one mass, slowly up one side of the cell, across the ends, and down the other side,—not perpendicularly, however, but in an oblique or spiral course, as indicated in fig. 125. The fluid in the centre does not circulate, but contains vesicles, granules, or other bodies floating in it, which are free, and when resting upon the protoplasmic sac, are carried along by it and up the side of the cell, until they fall down again by gravitation. The young cells from which the fruits are developed exhibit a circulation of green vesicles; the cortical filaments have a circulating primordial utricle without chlorophyll-globules.

The circulation is obscured in many *Charæ* by the existence of an incrustation of the cell-wall by carbonate of lime, often found in rhomboidal crystals. In *C.* (*Nitella*) *translucens*, *flexilis*, and other species, this does not exist; and these species without cortical tubes exhibit the phenomenon more clearly than the others. Those species, however, which are subject to incrustation have comparatively little about the tips of the shoots; and if they are kept growing for some time in a jar of water pretty free from lime, new shoots may be obtained very suitable for examination. When we carefully examine the conical terminal cell of a shoot, we find the following characters:—The cell-membrane is distinctly laminated, and thickened at the conical apex of the cell; when sulphuric acid and iodine are applied, the cell-wall exhibits a thick internal layer of a blue colour, indicating its composition of cellulose, while a thin layer extending all over the outside becomes bright yellow, and thus presents a resemblance to the cuticular layer of the higher plants. The cell-wall is lined by a thin layer of protoplasm, in which are imbedded a vast number of chlorophyll-globules, closely set and arranged spirally, as above stated; a clear line extends obliquely up in this layer, bare of chlorophyll. The chlorophyll-globules have much the appearance of vesicles here, and contain starch-corpuscles, which cause the whole layer to turn blue with iodine. (See CHLOROPHYLL.) Within this motionless layer is found the thick rotating layer of protoplasm, in which again are imbedded numerous starch and chlorophyll-globules, a vast number of minute granules, and a number of globular bodies of larger size, 1-1500″, according to Göppert and Cohn covered with rigid cilia. The internal boundary of this

Fig. 121.

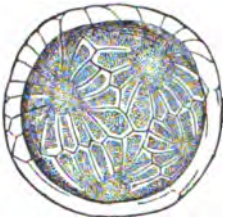


Fig. 124.

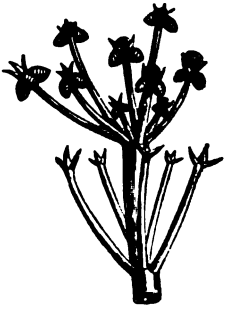


Fig. 122.

Fig. 125.

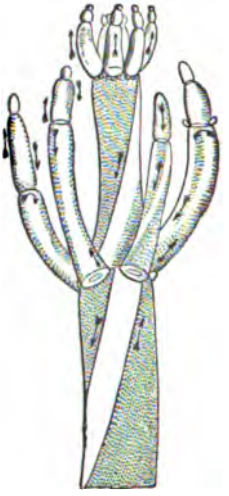


Fig. 123.

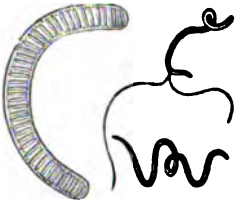


Fig. 121. A globule, magnified 50 diam., showing the triangular valves.

Fig. 122. A globule cut in half, to show the oblong cells and the septate filaments in the centre. 50 diam.

Fig. 123. Portion of a septate filament, 200 diam.; with two biciliated spermatozoids, 400 diam.

Fig. 124. Chara translucens, showing its simple tubes and nucules grouped in threes under the terminal globule.

Fig. 125. Diagram representing the course of the circulation in the main tube and branches of Chara.

layer is wavy and irregular; and thus its rotation carries along, to a certain extent, the watery juice filling up the centre of the cell, in which lie numerous transparent protoplasm-vesicles, ciliated bodies, and granular matters.

The fructification of *Chara* is very curious, and its homologies are not yet satisfactorily made out. Upon the branches are found bodies of two kinds, either on the same or on different branches, or on different plants; called the *globule* and the *nucule*. The *globule* (figs. 120, 121) or antheridium is a spherical body, of a red or orange-colour when ripe, presenting a transparent thickish outer coat, enclosing an inner wall of curious construction. This is composed of eight triangular plates, each composed of a number of long wedge-shaped cells radiating from a central cell. The plates have dentate margins, by which they fit into one another (fig. 121). The cells contain a red colouring-matter. In the centre of each plate, inside, rises an oblong cell running in toward the centre of the globule, where it meets its fellows from the other plates, and they are united by a little collection of spherical cells; a ninth cell, of similar form but larger size, comes to join these in the centre, it being the pedicle of the globule, arising from the branch upon which it is seated, and entering the globule between the lower four valves. At the point where these nine cells meet in the centre, a number of long septate filaments arise (fig. 122). These are composed, when mature, of a large number of cells placed end to end (figs. 122 & 123), each of which finally discharges a ciliated spiral filament (spermatozoid), which swims actively in the water. The globule bursts, by the separation of its triangular valves, when mature; and it is after this that the spermatozoids are emitted. The form of these spermatozoids is very like that of those found in the Mosses, and different from what is seen in the Ferns, Lycopodiaceæ, &c. (Pl. 40. figs. 31–34).

The *nucule* or carpogon of the *Charæ* (figs. 120 & 124) forms an oval body coated by five cells, wound spirally around a central tough sac; the five cells terminating above in five or ten smaller cells, which project like teeth from the summit, forming a kind of crown. The cells of the crown separate from each other at a particular period, leaving a canal leading down to the central cell, which contains protoplasm, oil, and starch-globules. Ultimately the nucule falls off, forms a resting-spore, which germinates, and becomes developed into a new plant. The germinating spore does not, however, directly give origin to the young plant; but, as in the higher Cryptogamia, a prothallus is first formed, and upon this, the first branches of the plant arise by ordinary gemmation. The prothallus consists of a single row of cells, forming a filament. This is not produced, however, in *Nitella*.

The *Charæ* also multiply by gemmæ, produced at the articulations of the stem; of which there are three modifications.

Carter has published some interesting observations on the development of the root-cells of *Chara*; also an account of the abnormal products which are sometimes found in decaying cells.

Bibl. Corti, *Osserv. sulla Circulazione*, 1774; Amici, *Mem. d. Società italiana*, 1818; *Ann. d. Sc. N.* 1824; Dutrochet, *Ann. d. Sc. Nat.* sér. 2. x. 349; Meyen, *Pflanzen-phys.* ii. 206; Varley, *Tr. Soc. Arts*, xlix. 1833; *Micr. Tr.* ii. 93, 1849; Slack, *Tr. Soc. Arts*, xlix.; Thuret, *Ann. d. Sc. Nat.* 2 sér. xiv. 65, 3 sér. xvi. 18; Treviranus, *Phys. d. Gewächse*, i. 1839; Kützing, *Phyc. gen.* 313; C. Müller, *Bot. Zeit.* 1845 (*Ann. N. H.* xvii. 254); Göppert and Cohn, *Bot. Zeit.* vii. 665, 1849; Braun, *Ber. Berl. Ak.* 1852–3 (*Ann. N. H.* 2 ser. xii. 297); Carter, *Ann. N. H.* 2 ser. xvi. 1, xix. 13; Pringsheim, *Jahrb.* 1864; Berk. *Suppl. Eng. Bot.* t. 2762; Nägeli, *Beit.* ii. 1860; De Bary, *Monatsb. Berl. Ak.* 1871; Sachs, *Bot.* 295.

CHARA'CIUM, Braun. — A genus of Confervoid unicellular Algæ, of doubtful position; reproduction by repeated binary division of the endochrome. Allied to *Hydrocytium*. Adherent to larger submerged Algæ. Perhaps only male spores of *Œdogonium* and allied genera.

Rabenhorst describes 13 species.

C. Sieboldii (Pl. 5. fig. 2). On filiform Algæ and freshwater mosses.

Bibl. Rabenhorst, *Fl. Alg.* iii. 82; Braun, *Alg. Umcell. Gen. nova*, 1855.

CHASMATOSTOMA, Engelmann.—A genus of Holotrichous Infusoria.

Char. Free, ovate or reniform; cilia long, matted; mouth near the centre of the flattened ventral surface, enclosing a minute undulating membrane.

C. reniforme. Fresh water; length $\frac{1}{160}''$.

Bibl. Engelmann, *Zeitsch. wiss. Zool.* 1862, ii.; Kent, *Inf.* 540.

CHEESE-MITE. See Acarus domesticus.

CHEESE-MOULD. See ASPERGILLUS.

CHEILANTHES, Sw. — A genus of Pterideæ (Polypodiaceous Ferns), nearly related to *Adiantum*. The marginal lobed indusium is very narrow; some species have the under surface of the leaves mealy, from the presence of microscopic hairs.

A large genus; tropical.

BIBL. Hooker, *Syn. Fil.* 131.

CHEILOSCYPHUS, Corda.—A genus of Jungermannieæ (Hepaticæ), founded upon *Jungermannia polyanthus*, L., which is not unfrequent in wet places.

BIBL. Hooker, *Brit. Jungerm.* pl. 62; Corda, in Sturm, *Deutschl. Fl.* ii. 19, 20, p. 35, pl. 9.

CHEILOSTOMATA. — A suborder of Infundibulate Polyzoa (marine).

Char. Orifice of cell filled with a thin membranous or calcareous plate, with a curved mouth, furnished with a moveable lip.

It is divided into two sections, containing numerous families and genera.

Tribe 1. *Articulata.* Polyzoarium jointed.

SALICORNARIIDÆ. Polyzoarium erect, cylindrical, dichotomously branched; cells arranged on all sides.

CELLARIIDÆ.

CELLULARIIDÆ. Polyzoarium erect, branches flat, linear, cells in the same plane.

Tribe 2. *Inarticulata.* Polyzoarium unjointed.

EUCRATIIDÆ (Scrupariidæ). Cells in one row.

AETEIDÆ.

GEMELLARIIDÆ. Cells in pairs opposite.

CABEREIDÆ. Branches narrow; cells in two or more rows, with whips or sessile birds' heads at the back.

BICELLARIIDÆ. As the last, but whips absent, and birds' heads stalked and jointed.

FLUSTRIDÆ. Zoarium expanded, foliaceous, and flexible.

MEMBRANIPORIDÆ. Expanded, incrusting, stony; cells horizontal, quincuncial.

MICROPORIDÆ.

CELLEPORIDÆ. Massive, globose, incrusting, or erect, stony; cells vertical to the common plane, irregularly heaped together.

ESCHARIDÆ. Expanded and leafy, or branching, stony; cells in the same plane, quincuncial.

CRIBRILINIDÆ, MICROPORELLIDÆ, MYRIOZOIDÆ.

PORINIDÆ. Polyzoarium incrusting, or erect and branched; cells with a raised tubular or subtubular orifice, and frequently a special pore on the front walls.

BIBL. Johnston, *Br. Zooph.*; Busk, *Cat. Mar. Polyz.* (*Brit. Mus.*); Gosse, *Mar. Zool.* i.; Hincks, *Polyzoa*, 1.

CHEIROCEPHALUS. See BRANCHIPUS.

CHEIROSPORA, Fries.—A genus of Melanconiei (Stylosporous Fungi), growing upon the twigs of the beech. The mycelium spreads under the epidermis, and bursts through in rounded or irregular, conical, black pustules, 1-20″ in diameter, which are composed of a large number of fine filaments, unequal in length, and waved, each terminating in a bunch of spores. The heads are formed of chains of spores like a *Penicillium*, when young, but crowded together more densely as they become more fully developed into a globular or oval head, about 1-700″; the spores about 1-4000″. This genus corresponds to *Stilbospora*, Montagne, *Myriocephalum*, De Notaris, and, apparently, *Hyperomyxa*, Corda; but the latter is said to have a mucous vesicle enclosing the head.

C. botryospora, Fr. On dead beech twigs, Berk. and Broome, *Ann. N. H.* 2 ser. v. 455. Fresenius finds a variety on the hornbeam.

BIBL. *Cheirospora*, Fries, *Summa Veget.* 508; *Stilbospora*, Fries, *Syst. Mycolog.* iii. 448; Montagne, *Ann. Sc. Nat.* 2 sér. vi. 338, pl. 18. fig. 5; *Hyperomyxa*, Corda, *Ic. Fung.* iii. fig. 78; Montagne, *Ann. Sc. Nat.* 2 sér. xx. 378; *Myriocephalum*, De Notaris, *Mem. Accad. Torino*, ser. 2. vii.; Fresenius, *Mykologie*, 39, pl. 5. figs. 1-9 (2tes Heft).

CHELIDONIUM, L.—A genus of Papaveraceous plants, remarkable for the yellow juice contained in the laticiferous canals. See LATEX.

CHELIFER, Leach.—A genus of Pseudoscorpiones (Arachnida).

Char. Cephalothorax with a transverse furrow; eyes 2; no tail.

C. cancroides (Pl. 53. fig. 12). Brown, palpi stout; length ⅛″. In old books, herbaria, etc., and shady places.

C. muscorum. Palpi weaker; abdomen with a small appendage at the last joint; reddish.

Many other species.

BIBL. Gervais (Walckenaer), *Ins. Apt.* 77; Murray, *Ec. Ent.* 34.

CHEMICAL REACTIONS. — INTRODUCTION, p. xlii.

CHEMISTRY.— The following works may be found useful for study or reference in regard to chemical subjects:—Stockardt, *Exper. Chem.*; Gmelin, *Handbuch*; Rose, *Anal. Chem.*; Will, *Chem. Analyse*; Fresenius, *Anal. Chem.*; Heintz, *Zoochemie*; Gorup-Besanez, *Zooch. Anal.*; Schmidt, *Entw. ein. allg. Untersuchungsmethode*; Hoppe-Seyler, *Tr. d'anal. chim. phys. et path.*; Miller, *Chem.*; Watts, *Dict.*; Roscoe, *Lessons &c.*, and his larger work; Engel. *Chim. méd. et biol.*; Mehu, *Chem. med.*; Ralfe, *Demonstr. in phys. and path. chem.*

The progress of chemistry is reported in the 'Chemical News.'

CHEY'LETUS, Latreille.—A genus of Acarina (Arachnida), of the family Trombidina.

Char. Rostrum prominent, palpi very thick, resembling arms, and falciform at the ends; antennal forceps (mandibles?) didactylous; tarsi with 2 simple claws. Koch describes 6 species; Michael and Mégnin add others.

C. eruditus (Pl. 53. fig. 13). Found in books and museums. Parthenogenesis has been found to occur in this species (Beck).

C. parasitivorus, found at the root of the hairs of rabbits, feeding upon *Listrophori*; *C. heteropalpus*, on the feathers of the Columbidæ &c.; *C. macronychus*, on the feathers of Insessores; *C. venustissimus*, on fodder in a stable; and *C. flabellifer*, on the walls of a beer-cellar (Michael).

BIBL. Gervais, *Walckenaer's Aptères*, iii.; Koch, *Deutsch. Crustac. &c.*; Robin, *J. de l'Anat.* 1867 (figs.), p. 506; Beck, *Mic. Tr.* 1866, 30; Murray, *Ec. Ent.* 285; Michael, *Jn. Mic. Soc.* 1878, 133 & 313 (figs.); Mégnin, *Parasites*, 1880, 240.

CHICKWEED, *Stellaria media.*—This common plant is of great interest to the microscopic observer, on account of the facility with which the embryo-sac may be dissected out. See Griffith, *Text-book*, 45, pl. 1.

CHICORY.—This substance, used for mixing with or adulterating coffee, consists of the roots of the plant of the same name (*Cichorium Intybus*). The structures composing the root (Pl. 2. fig. 6) are recognizable after it has been roasted and ground, consisting of membranous cellular tissue, *c*, short-jointed reticulated ducts of large size, *b*, and laticiferous tubes, *a*. Pure chicory does not appear to contain any starch-granules, this substance being replaced by inuline in most of the plants of this family. The presence of starch, therefore, in samples of chicory denotes adulteration, which, when effected by roasted corn or beans, is easily detected; and the integuments of roasted grain may often be identified. Other common adulterations are roasted carrots, parsnips, or mangel-wurzel: the first of these is difficult to detect, as the structure of the roots is very similar, as is the case to some extent with the parsnip, in which, however, traces of the starch usually remain; the parenchymatous tissue of mangel-wurzel is formed of cells very much larger than those of chicory. In addition to the above, certain substances containing astringent or colouring-matters are occasionally found in ground chicory and coffee—such as oak-bark and tan, mahogany and other kinds of sawdust. These are easily detected by the microscope, from the presence of woody fibre and liber-cells, the origin of which is often to be made out by careful comparative examination.

BIBL. Hassall, *Food and its Adulterations*, 108, 199, 352.

CHI'LODON, Ehr.—A genus of Infusoria, of the family Trachelina.

Char. Body covered with cilia; mouth with teeth arranged in the form of a tube; fore part of the head produced into a broad membranous or ear-like lip.

The cilia form longitudinal rows.

C. cucullulus (Pl. 30. fig. 27). Depressed, oblong, colourless, rounded at the ends, slightly auriculate or beaked anteriorly on the right side; freshwater and marine; length 1-1120 to 1-140″. (Pl. 30. fig. 27 *b*, side view.) Contains a red eye-spot.

C. uncinatus. Depressed, oblong, rounded at the ends, colourless; narrowed and curved anteriorly so as to appear hooked; fresh w.; length 1-430″.

C. aureus. Ovato-conical, turgid, golden-yellow, anterior end curved so as to form an obtuse beak, posterior end narrowed; aquatic; length 1-140″. A *Nassula* (?).

C. ornatus. Ovato-cylindrical, golden-yellow, ends rounded, a violet spot at the neck; aquatic and marine; length 1-174″. A *Nassula* (?).

Dujardin admits only the first species; referring the others to the genus *Nassula*.

BIBL. Ehr. *Infus.* 336; Duj. *Inf.* 490; Stein, *Inf. &c.*; Claparède and Lachmann, *Inf.* 335.

CHILOM'ONAS, Ehr.—A genus of Flagellate Infusoria, of the family Monadina.

Char. No tail nor eye-spot; body ovoid, oblong, surmounted by a lip; with two very delicate flagelliform filaments; revolving upon its centre.

C. volvox. Oval, narrowed and notched in front, colourless and transparent, lip long; fresh water; length 1-1400″.

C. paramecium. Oblong, keeled, trilateral, colourless and opaque, sometimes aggregated; fresh water; length 1-1020″.

C. destruens. Oblong, variable in form from its softness, colourless or yellowish; fresh water and marine; length 1-860″.

C. granulosa (Pl. 30. fig. 28). Oblong, broader in front, colourless, with granules which appear to project on the surface; length 1-840″. In an infusion of mosses.

C. obliqua. Ovoid or pyriform, nodular, colourless, variable in form; length 1-2700″.

Bibl. Ehrenb. *Infus.* 30; Duj. *Inf.* 295; Kent, *Inf.* 423.

CHILOSTOMEL'LA, Reuss.—A Foraminifer, consisting of subovate chambers, overlapping one another, almost completely, on opposite sides alternately; with crescentic almost terminal aperture.

Fossil (Tertiary), recent (Atlantic and Pacific).

Bibl. Reuss. *Denkschr. Ak. Wien*, 1850, i. 16; Brady, *Qu. Mic. Jn.* xix. 66.

CHIODEC'TON, Ach. — A genus of Lichens (tribe Graphidei), of which one species, *C. myrticola*, has been found in Ireland; and its var. *sarniense* in the Channel Islands.

Bibl. Leighton, *Ang. Lich.* 24, pl. 8. fig. 4, pl. 9. fig. 1; *Lich. Flor.* 435; Tulasne, *Ann. Sc. Nat.* 3 sér. xviii. pl. 10.

CHIONY'PHE, Thienem.—A genus of Mucorini (Phycomycetous Fungi), found growing upon melting snow.

Chionyphe Carteri, Berk., is a curious fungus, which is supposed to be the cause of that formidable disease the Fungus-foot of India. It has, however, been doubted whether it is really the cause, or only a secondary growth on the truffle-like nodules composed principally of stearine (?) which are characteristic of the disease. Hogg considers the disease somewhat similar to the amyloid lardaceous disease which attacks various other parts of the body.

Bibl. Thieneman, *Nova Acta A. C. L. C.* xi. 1839; *Ann. Sc. Nat.* 2 sér. xiv. 63; *Intell. Obs.* 1862; Berkeley, *Jn. Linn. Soc.* viii. 141, pl. 10; Carter, *Tr. Med. and Phys. Soc. Bombay*, 1861, 1862, 1863; *Ann. N. H.* vol. ix. 442, 1862; *Mn. Mic. Jn.* 1871.

CHIROD'OTA, Eschsch.—A genus of Echinodermata, closely allied to *Synapta*.

C. violacea possesses curious wheel-like calcareous plates in the skin.

Not British.

Bibl. V. der Hoeven, *Zool.* i. 150; Carpenter, *Microscope*, 564; Herapath, *Qu. Mic. Jn.* 1865, 1.

CHITINE is the horny substance which gives firmness to the tegumentary system and other parts of the Crustacea, Arachnida, and Insects; probably also the carapace of the Rotatoria consists of it. It is left when the above structures are exhausted successively with alcohol, ether, water, acetic acid, and alkalies, retaining the original form of the texture. It is dissolved by concentrated mineral acids without the production of colour. It is not dissolved by solution of potash, even when boiling. Neither does it give the characteristic reactions with Millon's or Schultze's tests. It contains nitrogen.

Bibl. Odier, *Mém. Mus. d'Hist. N.* i. p. 35; Lassaigne, *Compt. Rend.* xvi. p. 1087; Schmidt, *Vergl. Phys. d. wirbellos. Thiere* (Taylor's *Sc. Mem.* v. p. 1); Payen, *Compt. Rend.* xvii. p. 227.

CHLAMIDOCOC'CUS. See Protococcus; also Cienkowsky, *Bot. Zeit.* 1865; Rostafinsky, *ibid.* 1871; and Rabenhorst, *Fl. Alg.* iii. 94.

CHLAMID'ODON, Ehr.—A genus of Infusoria, of the family Euplota.

Char. Furnished with cilia and a cylinder of teeth, but neither styles nor hooks. (Oxytricha with a lorica and teeth.)

C. mnemosyne (Pl. 30. fig. 29). Elliptical or the anterior end somewhat broader, ovate; green or colourless, and containing rose-red vesicles; lorica projecting beyond the body; length 1-570 to 1-240″; marine.

Bibl. Ehr. *Infus.* 376; Kent, *Inf.*

CHLAMIDOM'ONAS (Pl. 30. fig. 30 *a, b, c, d, e*). See Protococcus.

CHLAMYDOCYSTIS, Grunow, = *Protococcus*, part.

CHLORAN'GIUM, Stein, = Colacium.

CHLORAS'TER, Ehr.—A genus of Flagellate Infusoria.

Char. Single, free, a single frontal eye-spot, no tail, middle of the body with radiate warty processes.

Allied to the genera *Glenomorum* and *Phacelomonas*. Does not admit coloured particles.

C. gyrans. Green, fusiform, acute at the

ends; radiate processes in a whorl of four, at first obtuse, then subacute; flagelliform filaments 4–5; length 1-1630″; fresh water.

It revolves radidly upon its axis, and undergoes spontaneous division.

Two other species, one marine.

Bibl. Ehr. *Ber. Berl. Ak.* 1848, 236; Kent, *Inf.* 315.

CHLORATE OF POTASH. See POTASH.

CHLO'REA, Nyl.—A genus of Lichens, family Lichenacei, tribe Usnei.

6 species. *C. vulpina* occurs in Europe.

Bibl. Nyl. *Syn.* 274, pl. 8. f. 13–15; Jacq. *Misc.* ii. pl. 10. fig. 4.

CHLORIDES. See the bases.

CHLOROCHYTRIUM, Cohn.—A genus of Confervoid Unicellular Algæ, allied to *Hydrocytium*, *Characium*, and *Chytridium*; consisting of single, globose-ovoid, or irregularly curved, 2–3- or multilobed cells, densely filled with green protoplasm; first dividing into larger segments, then separating into innumerable pyriform zoospores, escaping through a tubular process.

C. lemnæ. In the parenchyma of *Lemna trisulca*; diam. $\frac{1}{175}$″.

Bibl. Cohn, *Beitr.* i. 1, 87; Wright, *Tr. Irish Acad.* xxvi.

CHLOROCOC'CUM, Grev.—A genus of Palmellaceæ (Confervoid Algæ).

We have assigned to this the common green pulverulent stratum which is found upon every old tree, on all old palings and other exposed woodwork, &c. If this proves to be really a distinct plant, and not an accumulation of germinating gonidia of Lichens, it will still differ from the plants we have assembled under the name of *Protococcus* in its general habit, especially in the absence of zoospores. This point is, however, still open to inquiry, since it appears that the gonidia of the Lichens do divide into two, four, and eight, to form a pulverulent stratum, which exactly represents *Chlorococcum* and *Protococcus*.

Chl. vulgare, Grev. (Pl. 7. fig. 1). A collection of extremely minute cells, multiplying by division into twos and fours, no gelatinous substratum, no zoospores. Diameter of single cells 1-3000 to 1-4000″ (*Protococcus viridis*, 1-2000 to 1-3000″). Old dry palings, bark of trees, &c. everywhere. Calculating from the known size of the cells and the wide distribution, this, if a species, would appear to be the most fecund Alga in existence. There are 300 millions of individuals on a square inch, in a layer 1-100″ thick; and such layers clothe almost every piece of unpainted timber and old trunk we meet with in the country. *C. murorum*, Gr. is perhaps a *Palmoglœa*, Kütz.

Rabenhorst remarks that this species closely resembles the gonidia of Lichens, but that the cells have a nucleus, which is wanting in the Lichen-gonidia. This is, however, incorrect, as the nucleus is quite distinct in these gonidia.

Rabenhorst describes 12 species; but places *C. vulgare* in the genus *Pleurococcus*.

Bibl. Greville, *Crypt. Fl.* pl. 262; Hassall, *Algæ*, pl. 81. fig. 5.

CHLOROGO'NIUM, Ehr.—A genus of Infusoria, of the family Astasiæa.

Char. A red eye-spot, a tail, and two anterior filaments. (Not attached by a fixed pedicle.)

C. euchlorum (Pl. 30. fig. 31). Spindle-shaped, acute at each end, tail short; length 1-1150 to 1-280″. Found in enormous numbers in pools and puddles; frequently as many as 10,000 in a single drop.

These organisms do not admit colouring-matter or foreign bodies; hence they are probably not Infusoria, but Algæ. They often adhere to each other in groups by the so-called tails (Pl. 30. fig. 31, upper figure), sometimes to foreign bodies (Pl. 30. fig. 31, lower figure), which exhibits them adhering to a dead *Vorticella*).

They undergo oblique spontaneous division (Pl. 50. fig. 1); this commences in the internal substance, which is constricted before the outer portion.

They also propagate by a process of swarming, which takes place thus: the internal substance first separates somewhat from the transparent wall, subsequently becoming irregularly constricted at various parts. The constrictions deepening, the constricted portions separate from each other as independent vesicles (?), and the internal substance acquires the appearance of a blackberry or bunch of grapes, consisting of a fusiform aggregation of uniform longish oval granules. Up to this period, the parent organism continues its movements; subsequently these cease. The granules have now acquired independent vitality, and their filaments become developed. The envelope then breaks near its middle, and the swarm of young ones escape. In their somewhat more developed stage they form *Glenomorum tingens*, Ehr. See PROTOCOCCUS.

Bibl. Ehr. *Infus.* 113; Weise, *Wiegmann's Archiv*, 1848, i. 65; Stein, *Infus.* 188.

CHLOR'OPHYLL (leaf-green). — The name applied to the green colouring-matter of plants. The nature of the substances which are understood under this term is still somewhat questionable. It is ordinarily stated that chlorophyll exists commonly under the form of globules or granules, and occasionally as an amorphous granular substance, in either case more or less adherent to, or imbedded in the primordial utricle of the cell. It is, however, a contested point whether the chlorophyll-corpuscles are semisolid homogeneous globules in which the chlorophyll is imbedded, or vesicles composed of a delicate membrane enclosing a green liquid: the former view is now, however, generally adopted. Chlorophyll presents itself in the form of distinct corpuscles (*granules* of authors), in the cells of the flowering plants generally, particularly the parenchyma of leaves and the subepidermal parenchyma of green stems and shoots. The granules are especially large and distinct in certain water-plants, and may be well seen lying scattered, singly, imbedded in the circulating protoplasm of the cells of the leaves of *Vallisneria* and other water-plants. The corpuscles are very evident in the cells of the prothallia of Ferns, in the leaves of *Selaginella*, of Mosses and Liverworts; also in *Chara*, where they are very abundant and form a continuous layer, or numerous rows, embedded in a gelatinous stratum between the cell-wall and the circulating mass of protoplasm. In the Confervoids the chlorophyll often appears both formless and corpuscular in one and the same cell, but usually more or less formless in young cells, and more completely converted into granules in the full-grown, as in *Vaucheria*. In the Confervaceæ, such as *Cladophora*, and in *Œdogonium*, it presents itself in a granular stratum with numerous larger bright corpuscles; and in *Spirogyra*, *Zygnema*, &c. the chlorophyll takes the form of the spiral or annular band to which it is adherent, without large granulations in the general mass, but with a number of distinct, large, bright-looking corpuscles at intervals (Pl. 9. fig. 18). In *Protococcus*, in zoospores, and in the individual ciliated bodies of the Volvocineæ, the chlorophyll appears to tinge the general mass of granular protoplasm, leaving the conical apex (beak) uncoloured (Plates 7 & 9), while more or less distinct corpuscles or granules are scattered through the mass, varying in number and size at different periods. When any of these forms of chlorophyll are treated with ether, benzole, alcohol, or chloroform, the colour is abstracted, while the organized forms, the corpuscles, &c., remain; so that the true chlorophyll is really only a soluble substance, dyeing the bodies called chlorophyll-corpuscles &c. It becomes a question then whether these are homogeneous semisolid corpuscles, or vesicles containing the colouring-matter in sacs, from which it is extracted by the ether &c. Nägeli and others assert the vesicular character of the chlorophyll-corpuscles and the appearances are sometimes much in favour of this view; but in the many cases in which we have obtained the appearance of a double line around them, under high magnifying powers, we have never been able to divest ourselves of the impression that this was an optical illusion. Nägeli asserts that the corpuscles multiply by division, which is true, but does not prove that they are vesicular structures. The observation of Göppert and Cohn, of a chlorophyll-corpuscle swelling up and bursting through endosmose, may be explained without supposing a regularly organized coat. We are inclined to believe that the bodies bearing the green colouring-matter are structures belonging to the protoplasm, the green colour being only an additional character, produced by the action of light, superadded to the ordinary character of the granular structurs occurring in the protoplasm or nitrogenous cell-contents. See PROTOPLASM.

A very important point connected with chlorophyll is its relation to starch. The bodies called starch-granules occur very commonly with chlorophyll-corpuscles in the cells of the green parts of plants, and they become substituted for each other under varying circumstances. Some authors have imagined that chlorophyll is produced by a chemical decomposition of starch, while others think that starch is developed from chlorophyll. The chief ground for the latter view is the fact that starch-granules are often found in the centre of chlorophyll-corpuscles, like a kind of nucleus. We have traced, in Hepaticæ, the gradual formation of a group of starch-granules in the interior of a chlorophyll-corpuscle (where they are readily detected by the application of iodine); and this goes on in certain cases until almost all the green colour is lost. Starch occurs universally at a certain period in the bright distinct

chlorophyll-corpuscles of *Chara* and of the Confervaceæ, *Spirogyra* &c.; so that these are coloured blue by iodine, although green before its application. But this starch may disappear again in the course of nature, for it always vanishes from these corpuscles when they are about to become organized into zoospores. In fact the green chlorophyll is predominant during active vegetation, and starch in periods of rest or in full-grown structures. Moreover, while chlorophyll may appear independently in young cells without being preceded by starch, in green tissues starch makes its appearance without previous existence of chlorophyll-corpuscles in subterranean structures, as for example in the potato and other tubers. The truth of the matter therefore appears to be, that the chlorophyll-structures, as above stated, are granular structures belonging to the general protoplasm or nitrogenous cell-contents, that they become coloured green in the light by a chemical change connected with the vital processes, and that in undergoing this change they do not lose the power, which the ordinary protoplasm possesses, of secreting starch and decomposing it again when required for the nutrition of the plant. Starch-granules, when free and uncoloured, appear to be produced originally from granular or vesicular protoplasmic structures, only differing by absence of colour from chlorophyll structures. For example, the granular protoplasm around the cell-nucleus in the cells of herbaceous Monocotyledons (such as the Lily, *Tradescantia* &c.) will sometimes become converted into chlorophyll- granules (in superficial cells), inside which starch may be subsequently developed; but (in deeper-seated cells) the granular protoplasm may give rise at once to starch-granules (Pl. 46. fig. 28 *a*) without the previous existence of the green modification of the protoplasm, *i. e.* chlorophyll.

The views of the nature of chlorophyll above expressed (in the first edition of this work) have been since confirmed by the observations of v. Mohl and Gris; and repeated observations have furnished us with similar results. In Caspary's observations on Hydrilleæ also, will be found confirmation of the statement that the supposed vesicular structure is an illusion.

Chlorophyll occurs in the animal, as well as in the vegetable kingdom—thus in Infusoria (*Stentor* &c.), the zoophytes (*Hydra*), the Turbellaria, Aphidæ, &c.

Chlorophyll-corpuscles, when set free in water, expand by imbibing water, sometimes becoming vacuolated and bursting. Alcohol and most acids coagulate them, while acetic acid will often blend the corpuscles into an irregular mass.

After the separation of the chlorophyll, the protoplasmic base retains both its form and volume; constituting a solid soft body, often containing small vacuoles.

Chlorophyll is turned yellow-brown by tincture of iodine; sulphuric acid gives it a more or less deep blue colour; ether and alcohol discharge the green tint. Preparations mounted in chloride of calcium or glycerine often lose their green colour; those preserved in water will sometimes retain it a long time. The green colouring-matter extracted by alcohol is a complex substance, containing a kind of wax and a matter allied to indigo.

It was formerly considered that chlorophyll was the only colouring-matter of plants, capable under the influence of oxygen of producing all the varied and beautiful colours of flowers. Subsequently, two colouring-matters, a blue-phyllocyanine, and a yellow-phylloxanthine, have been separated by chemical reagents, and considered as the real colouring-matters, which by their mixture produced the most varied colours. The old view has lately been revived; but the whole question must at present be considered as unsettled.

In autumn, at the fall of the leaf, the chlorophyll becomes dissolved, and conveyed to the perennial portions of the plants, the cells become filled with liquid containing crystals and a number of bright yellow granules; if the leaves are red, this arises from a substance dissolved in the liquid, the yellow granules being also present.

Bibl. Mohl, *Veget. Cell.* (*Transl.* 1852), 41; *Vermischte Schriften*, 349; *Botan. Zeit.* 1855 (*Ann. N. H.* 2nd ser. xv. 321); Nägeli, *Zeitsch. f. wiss. Bot.* iii. 110 (*Ray Soc.* 1849); Mülder, *Physiol. Chem.*, *Tr.* 266; Göppert and Cohn, *Bot. Zeitung*, 1849, vii. 665; Schleiden, *Grundzüge wiss. Bot.* 3rd ed. 196; Braun, *Verjüng.* (*Ray Soc.* 1853, 195); Morot, *Color. des Végétaux*, *Ann. Sc. Nat.* 3 sér. xiii. 160; Guillemin, *Ann. Sc. Nat.* 4 sér. vii. 155; Gris, *ibid.* 1857, vii. 179; Caspary, *Pringsheim's Jahrb. wiss. Bot.* i. 399, *ibid.* 1881; Fremy, *Compt. Rend.*, l. 405; Gmelin, *Handb. Chem.* vii. 1430; Hofmeister, *Pflanzenzelle*, 1867, sect. 41; Kraus, *Jahr. wissensch. Bot.* 1871, viii.

131; Henfrey-Masters, *Bot.* 498; Sachs, *Bot.* 729; Sorby, Beale, *How &c.*, 278; Kraus, *Z. Kenntniss. d. Chl. Farbstoffe*, 1872 (Spectroscope); Askenasy, *Bot. Zeit.* 1867, 225; Geddes, *Proc. Roy. Soc.* no. 194 (*Qu. Mic. Jn.* 1879, xix. 434); Palmer, *M. M. J.* 1877, xvii. 225 (figs.).

CHLOROP'TERIS, Mont.—A genus of Confervaceæ (Confervoid Algæ).

1 species: not British. Rabenhorst, *Fl. Alg.* iii. 346 (fig.).

CHLOROSPHÆ'RA, Henfrey (ERE-MOSPHÆRA, De Bary).—A genus of Unicellular Algæ, probably related to Œdogonieæ (Rabenhorst places it among the Palmellaceæ); of which one species, *C. Oliveri* (*E. viridis*, De B.) (Pl. 5. fig. 4) is known, consisting of a single globular cell, about 1-200″ in diameter, densely filled with green contents, sometimes exhibiting a radiated appearance. The cell is multiplied by dividing into two parts by a septum, and forming a new perfect cell in each half, the two new cells escaping through slits in the parent-cell membrane, with elasticity, when mature. Resting-spores, formed in fours in a parent-cell and of a brown colour, have been observed, but not their germination nor any formation of zoospores. *C. Oliveri* was found in a boggy ditch, at Prestwich Car, Northumberland. It has been found elsewhere in turfy pools.

BIBL. Henfrey, *Mic. Trans.* 1859, vol. vii. 25; De Bary, *Conj.* 56.

CHLOROTYLIUM, Ktz.—A genus of Chætophoraceæ (Confervoid Algæ).

Char. Filaments jointed, repeatedly dichotomous, parallel; joints of two kinds, some elongate and colourless, others swollen, abbreviate, and with green endochromes.

4 species. On rocks, submerged timber, and the bottom of ponds.

BIBL. Kützing, *Sp. Alg.* 432; Rabenhorst. *Fl. Alg.* iii. 386 (fig.).

CHOCOLATE. See COCOA.

CHŒ'NIA, Quennerstedt.—A genus of Holotrichous Infusoria.

Char. Free, elongate, with a brush-like tuft of large cilia at the anterior extremity.

C. teres, marine, = *Trachelius t.* Duj.

BIBL. Kent, *Inf.* 521.

CHOIROMY'CES.—A genus of Tuberacei (Ascomycetous Fungi) characterized by a definite base, even common integument, clavate asci and spherical sporidia.

C. meandriformis, Vitt., occurs occasionally in Great Britain. It sometimes attains a considerable size.

BIBL. Vitt. *Mon. Tab.* 50; *Ann. N. H.* xviii. 80; Sow. *Fung.* t. 310; Tul. *Fung. Hyp.* 170, tab. xix. fig. 7.

CHOLERA.—The attempt has often been made to discover some animalcule or minute vegetable organism in the air, water, and the intestinal and other animal liquids, during the existence of cholera, which might explain the origin of this fearful disease; and statements have been published announcing success. None of these have, however, stood the test of rigid investigation. When the cholera prevailed at Berlin in 1832, the renowned Ehrenberg, who had then been engaged in the study of microscopic organisms for many years, declared, after special and careful examination, that neither the air nor the water from various localities contained any thing unusual. Repeated examinations of the air and water of infected localities, made in 1849, and during the more recent accessions of the cholera, have afforded also conclusive negative evidence.

Hallier subsequently attempted to show that it was probably derived in the first instance from a fungus infesting rice. It is, however, a remarkable fact that rice is far less subject to attacks of Fungi than any other cereals. The researches of Thwaites and others have been directed to this especial point, and have in no respect confirmed Hallier's views; added to which, it was quite evident that the fungus which appeared in cholera-evacuations was not the *Urocystis*, to which he referred it. De Bary altogether denied the justice of his views. Lewis and Cunningham were placed by the government authorities in communication with De Bary and Hallier, and quite accorded with the former of the two; and the very careful observations of Lewis at Calcutta confirm De Bary's views. See MICROZYMES.

The methods of examining the air in regard to this point are described under AIR.

BIBL. Baly and Gull, *Rep. of Cholera Subcommittee of Roy. Coll. Phys., London*, 1849; Robin, *Végét. Parasites, &c.*, 1853, appendice, 676; Hallier, *Das Cholera-Contagium*; *Privy Council Reports*, 1866 and 1870; Sansom, *Jn. of Science*, 1871, 153; Berkeley, *Mic. Jn.* July 1869; Lewis, *Report on Objects found in Cholera-evacuations*; and *Med. Chi. Rev.* 1871.

CHOLERA-FLY.—Knox, *Lancet*, 1853, ii. 479.

CHOLES'TERINE. — This substance exists naturally in most animal liquids in a state of solution; also in many animal solids, as in the blood, the bile, the meconium, the brain and spinal cord. As an abnormal product, it occurs in the crystalline form in the bile, biliary calculi, various dropsical effusions, the contents of cysts, pus, old tubercles, malignant tumours, the excrements, expectoration of phthisis, &c.

In the vegetable kingdom it occurs in peas, beans, almonds, many seeds, &c.

The crystals form thin pearly rhombic plates (Pl. 13. fig. 21). The acute angles are =79° 30′, the obtuse =100° 30′. Sometimes the angles are truncated.

Cholesterine is insoluble in water and solution of potash, even when boiling; but soluble in ether and boiling alcohol, crystallizing on cooling.

It is most easily procured from a gallstone by boiling in alcohol; it falls on cooling. The crystals thus obtained are usually thicker than the natural plates.

CHONDRACAN'THUS.—A genus of Crustacea, of the order Siphonostoma, and family Lernæopoda.

C. Zei. Found upon the gills of *Zeus*, the Dory. Body is covered with short reflexed spines. Length 4-5″.

BIBL. Baird, *Brit. Entomostr.* 327; Mégnin, *Parasites*, 442.

CHONDRIA, Ag. See LAURENCIA.

CHONDRINE.—The gelatinous matter of the permanent true cartilages.

Its solution differs from that of the gelatine of bones &c., in being precipitated by acetic acid, acetate of lead, and alum. The acetic precipitate is insoluble in excess.

It is coloured red by Millon's test; but is unaffected by that of Pettenkofer.

CHON'DRUS, L.—A genus of Cryptonemiaceæ (Florideous Algæ), composed of cartilaginous sea-weeds with flat dichotomously-divided fronds, the cellular structure of which exhibits three layers—a central of longitudinal filaments, an intermediate of small roundish cells, and an outer of vertical coloured and beaded rows of cells, the whole imbedded in a tough "intercellular" matrix. See INTERCELLULAR SUBSTANCE.

Fructification: *spores* contained in favellidia immersed in the frond; *tetraspores* collected in imbedded sori; and "*nemathecia*," tubercles composed of radiating filaments (antheridia?). *C crispus* becomes horny when dry, and is the Irish moss or *Carrageen* of the shops.

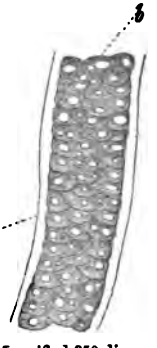
BIBL. Harvey, *Br. Mar. Alg.* pl. 17 D; *Phyc. Brit.* pl. 63 & 187; Greville, *Alg. Brit.* pl. 15.

CHOR'DA, Stackh.—A genus of Laminariaceæ (Fucoid Algæ), with fronds of a peculiar, simple cylindrical form; two species, *C. filum* and *C. lomentaria*, are found between tide-marks on British coasts; the former grows from 1 to 20 or even 40 feet long, with a greatest diameter at half its length, of 1-4 to 1-2″. The cord-like frond is tubular, but has at intervals thin diaphragms, formed by interwoven transparent filaments. The wall of the tube is composed of a number of layers of very regular six-sided cells, upon which are implanted little erect clavate cells which coat the entire surface of the frond. These present two forms, apparently constituting *oosporanges* (*spores*, Harvey, *paranemata*, Ag.) and *trichosporanges*, (*antheridia*, Harvey, *spores*, Ag.). The first are single sacs producing a number of zoospores; the second are filaments composed of about five joints, each of which gives birth to a zoospore.

BIBL. Harvey, *Br. Mar. Alg.* 31, pl. 3 B; *Phyc. Brit.* 107, &c.; Thuret, *Ann. Sc. Nat.* 3 sér. xiv. 240, pl. 29. figs. 5–10; Derbès and Solier, *Ann. Sc. Nat.* 3 sér. xiv. 268, pl. 33, figs. 7–10; Kützing, *Phyc. gen.* pls. 28 & 29.

CHORDA DORSA'LIS, or NOTOCHORD.—The embryonic representative of the spinal column of the Vertebrata; the permanent spinal column of the Cartilaginous Fishes. It sometimes forms a spindle-shaped, transparent, gelatinous-looking cord, with the broadest part near the tail; at others it is cylindrical or conical, rounded anteriorly and tapering posteriorly.

Fig. 126.



Magnified 350 diam.

Portion of the chorda dorsalis of the embryo of a sheep, rather more than 1-2″ in length. *a*, sheath; *b*, cells.

It usually consists of an outer comparatively thick and firm structureless membrane, forming a sheath, and of pale nucleated cells, which fill the sheath (fig. 126). In some instances, however, its structure is

fibrous, and that of the sheath fibro-membranous. The cells are mostly angular or polyhedral, and closely crowded. Their size varies; in the embryo of a sheep rather more than 1-2″ in length, they measured about 1-1800″.

The walls of the cells readily dissolve in solution of potash; but they yield neither gelatine nor chondrine on boiling. The liquid within the cells is not coagulated by boiling, but the chorda itself becomes cloudy and granular.

In its earlier stage of development, the chorda consists simply of a longitudinal band of ordinary formative or embryonic cells; the sheath is subsequently formed. It appears that the spinal column is not developed from the chorda itself, but from a blastema secreted by its component cells and effused around them.

The chorda is most readily examined in the larvæ of frogs (tadpoles), of Tritons, or of Fishes, and may be separated by macerating the dead animals for twenty-four hours in water. On cutting off the tail, it may then be pressed out by gently scraping along its course from the end of the tail, or from the head towards the wound. It is a beautifully delicate structure, and closely resembles in appearance a piece of vegetable cellular tissue.

Bibl. Kölliker, *Mikr. Anat.* ii. 346; Stannius, *Vergl. An.*; Gegenbaur, *Verg. An.* 450; Frey, *Hist.* 197.

CHORDA'RIA, Ag.—A genus of Chordariaceæ (Fucoid Algæ), remarkable for the solidity of the cellular texture of the filiform fronds. The axis and branches are composed of a central mass of longitudinal cells, upon which stand horizontal clavate filaments, formed of a row of beaded cells, constituting a distinct peripheral layer, which gives a velvety texture and slimy character to the surface. The so-called spores attached to the horizontal filaments are *oosporanges*, and discharge zoospores when mature; trichosporanges have not yet been observed. *C. flagelliformis*, Müll., is common on rocks and stones between tide-marks.

Bibl. Harvey, *Br. Mar. Alg.* pl. 10 A; *Phyc. Brit.* pl. 111; Thuret, *Ann. Sc. Nat.* 3 sér. xiv. 237.

CHORDARIA'CEÆ.—A family of Fucoid Algæ. Olive-coloured sea-weeds with a gelatinous or cartilaginous, branching frond, composed of vertical and horizontal filaments interlaced together; the oosporanges and trichosporanges attached to the filaments forming the superficial layers of the frond. British genera:

Chordaria. Axis cartilaginous, dense filaments of the circumferance unbranched.

Mesogloia. Axis gelatinous, loose filaments of the circumference branching.

Bibl. Harvey, *Marine Algæ*; Thuret, *Ann. Sc. Nat.* 3 sér. xvi. 5, &c. See also the genera.

CHORIOP'TES, Gervais.—A subgenus of *Sarcoptes*, with the body bilobed, or notched posteriorly, the mandibles short, didactylous, the tarsi with strong claws, and very large suckers.

C. bovis (*spathiferus*); on the legs and hind quarters of the horse, the goat, and the ox; *C. setiferus*, on the hyæna and fox; *C. ecaudatus*, in the ears of dogs, cats, and ferrets. There are other doubtful species.

Bibl. Mégnin, *Parasites*, 198 (figs.); Murray, *Ec. Entom.* 312 (fig).

CHORIZOP'ORA = *Lepralia* pt. *C. Brongniartii*. Cells connected by a tubular network. Marine.

Bibl. Hincks, *Polyzoa*, 222.

CHOROID MEMBRANE. See Eye.

CHROMATE OF LEAD (neutral) is one of the best materials for colouring size in injections. See Injection.

CHROMIC ACID may be prepared by adding gradually from 120 to 150 parts, by volume, of pure concentrated sulphuric acid to 100 parts of a cold saturated solution of bichromate of potash. The crystals of the acid separate as the solution cools. The mother-liquor should be poured off, and the crystals dried upon a tile; they may be purified by re-crystallization from solution in water. With excess of sulphuric acid, chromic acid is a valuable reagent for dissolving the intercellular substance of plants.

Chromic acid is readily decomposed by organic matter, as dust &c., and must therefore be preserved in a well-stoppered bottle. Its aqueous solution, which should be of a pale yellow colour, is used for hardening and preserving nervous and muscular tissues, &c. It should be prepared when required.

CHROMOPH'YTON, Woronin. — A doubtful organism, probably allied to the Palmellaceæ, forming a yellowish-brown dust on the surface of boggy pools (Finland). Two forms were met with: the larger consisted of spherical moniliform or variable bodies, composed of a hyaline matrix, con-

taining rounded or ribbon-shaped yellow 1-ciliated zoospores, 1-3000″ long, each with a yellow pigment-spot, and containing one or two contractile vesicles; these multiplied by division. The finer had the same composition as the larger. Resting-spores were formed in the empty cells of *Sphagnum* and *Hypnum*, from which the motile forms were traced.

C. Rosanoffii, the single species.

Bibl. Woronin, *Bot. Zeit.* 1880, 625, 641; *Jn. Mic. Soc.*, 1881, i. 100.

CHROOCOC'CUS, Näg. See Protococcus. Rabenhorst retains this, as a genus, with 23 species.

CHROOLEPUS, Ag.—A generic name applied to certain byssoid structures found on rocks, bark of trees, &c. They consist of jointed, variously branched filaments, the joints expanding to form sporangia, filled with biciliate zoospores. *C. aureum* (Pl. 3. fig. 7) is composed of rigid opaque, ultimately brittle filaments, forming soft cushions of a yellowish colour; *C. Jolithus*, *odoratum*, and *lichenicola* are of orange or fulvous colour. Another series of species, *C. ebenea* &c., are black, or purple. These plants have been regarded sometimes as Fungi and sometimes as Algæ.

Rabenhorst describes 11 species: the genus forming the type of the family Chroolepidæ (Confervoid Algæ). Reproduction by biciliated zoospores. Some species emit a violet-odour.

Bibl. Hooker, *Brit. Flora*, v. pt. 1. 384; *Engl. Bot.* pl. 702 & 1639; Kützing, *Spec. Alg.* 425; Caspary, *Flora*, 1858, 561; Rabenhorst, *Fl. Alg.* iii. 371.

CHRYSALIDI'NA, D'Orb.—A Textularian Foraminifer, with a triserial arrangement of chambers and with large pores, and sometimes tubes, opening from chamber to chamber. *Ch. gradata*, D'Orb., is from the Cretaceous strata of France. A dimorphous form, which is uniserial in its old state, lives in the Indian ocean and Panama Bay.

Bibl. D'Orbigny, *For. Foss. Vien.* 194; Carpenter, *Introd. Foram.* 193.

CHRYSIME'NIA, J. Ag.—A genus of Laurenciaceæ (Florideous Algæ).

C. clavellosa is a red sea-weed 3 to 12″ high, forming a feathery frond composed of a branched, tubular, long, not constricted or chambered, cellular structure, filled with a watery juice. The spores are angular and are contained in dense tufts in ceramidia borne on the sides of the branchlets. The tetraspores are 3-partite and immersed in the branchlets.

Bibl. Harvey, *Br. Mar. Alg.* pl. 13 A; *Phyc. Brit.* pl. 114.

CHRYSO'MONAS, Stein.—A genus of Flagellate Infusoria.

C. flavicans = *Monas fl.* Ehr.; has the body ovate, a terminal flagellum, two lateral colour-bands, no dilated pharynx, and an eye-spot. Ditch water.

Bibl. Kent, *Infus.* 408.

CHRYSOPYX'IS, Stein.—A genus of Flagellate Infusoria.

Char. Bodies ovate, contained in a sessile lorica; flagella 2, equal; two colour-bands, but no eye-spot.

C. bipes. Lorica with two posterior spines. Attached to the cells of *Mougertia* or other freshwater algæ.

Bibl. Kent, *Infus.* 408.

CHTHONOBLAS'TUS, Kütz. See Microcoleus.

CHY'DORUS, Leach (*Lynceus*, Müll., in part).—A genus of Entomostraca, of the order Cladocera, and family Lynceidæ.

Char. Nearly spherical; beak very long and sharp, curved downwards and forwards; inferior antennæ very short.

C. sphæricus (Pl. 20. fig. 7). Shell smooth; olive-green. Found in ponds and ditches.

C. globosus. Shell more rounded than in the last, and nearly six times as large; anteriorly reddish, with circular striæ and numerous black spots; fresh water.

Bibl. Baird, *Brit. Entom.* p. 125; Norman and Brady, *Brit. Entom.* pp. 47, 48.

CHYLA'QUEOUS or chylo-aqueous liquid and system.

In the Invertebrata, two distinct kinds of nutrient liquids exist. In some classes of this subkingdom, these two liquids coexist in the same organism, though contained in distinct systems of conduits; while in others they become united into one. Williams distinguishes these two kinds of liquid as the *blood proper* or true blood, and the *chylaqueous* liquid. The former is always contained in definitely organized (walled) blood-vessels, and has a determinate circulatory movement; the latter, with equal constancy, in chambers, irregular perivisceral cavities, and cells communicating invariably with the peritoneal cavity; not having a determinate circulation, but a to-and-fro movement, maintained by muscular and ciliary agency. The true-blood system does not exist under any form, even the most rudimentary, below the Echinoder-

mata; in other words, the true-blood system begins at the Echinodermata. Below the Echinodermata, viz. in the Polypi and Acalephæ, the digestive and circulatory systems are identified, consequently the external medium is admitted directly into the nutrient vessels. This circumstance constitutes a fundamental distinction between the chylaqueous system and that of the true blood, into which, under no conditions, is the external inorganic element directly introduced.

In every class in which the chylaqueous liquid exists, it is charged more or less abundantly with organized corpuscles. These corpuscles are marked by distinctive characters, not in different classes and genera only, but in different species, entitling these bodies to great consideration in the establishment of species. In those classes, as the Echinodermata, the Entozoa, and Annelida, in which, in the adult animal, these two orders of liquids coexist, though distinct, in the same individual, an inverse proportion prevails between them, as respects their magnitude or development. The system of the chylaqueous liquid does not exist in the adult, but only in the larval state of the higher members of the articulated series, as the Myriapoda, Insecta, and the Crustacea.

Bibl. Williams, *Trans. and Proc. of Roy. Soc.* 1852 (the former contains figures of the corpuscles); id. *Ann. N. H., passim* after 1852; Agassiz, *Sieb. and Köll. Zeitschr.* 1856, vii. 176; Nicholson, *Zool.* 1878.

CHYLE.—The chyle consists of a liquid which coagulates when removed from the vessels, containing in suspension molecules, nuclei, colourless corpuscles, and coloured blood-corpuscles.

The *molecules* (Pl. 50. fig. 2 *a*) are very numerous, and probably consist of fatty matter surrounded by a coat of a proteine-compound; to them is owing the milky appearance which the chyle possesses during active digestion. They form the molecular base of Gulliver. The *free nuclei* (Pl. 50. fig. 2 *b*) have a somewhat homogeneous aspect; they are not numerous, about 1-11,000 to 1-5600″ in diameter, frequently appearing cell-like and granular after the addition of water. They are only met with at the origins of the lacteals, in the mesentery, and in the vasa efferentia of the mesenteric glands, but never in the thoracic duct. The *chyle-corpuscles* (Pl. 50. fig. 2 *c*), which are identical with those of the lymph and the colourless corpuscles of the blood, are pale, round, nucleated cells, 1-4500 to 1 2000″ in diameter; their contents become turbid when water is added; and they are rendered very transparent by the addition of acetic acid, the granular nucleus becoming at the same time very distinct. Sometimes they exhibit a number of Amœba-like processes (Pl. 50. fig. 2 *d*). At the origins of the lacteals the chyle-corpuscles are few in number, or even absent; near the mesenteric glands, they are met with undergoing division. The coloured blood-corpuscles are probably derived from without. Chemically, the chyle consists of a saline liquid, containing albumen and fibrine in solution, the latter when coagulated forming a soft and loose clot.

Bibl. Kölliker, *Mikrosk. Anat.* ii. 561; Wagner, *Handwört.* art. *Chylus*; id. *Elem. of Phys.*, by Willis; Gulliver, *Gerber's Anat.*; Lister, *Dublin Hosp. Gaz.* 1857, 347; Frey, *Histol. &c.* p. 146; and the Bibl. of Chemistry.

CHYLOCLA'DIA, Grev.—A genus of Laurenciaceæ (Florideous Algæ), containing a few British species, with fronds of small size, composed of a branched, cylindrical and tubular structure, cut off into chambers within by diaphragms at intervals, and filled with a watery juice. The walls are composed of small polygonal cells. Nägeli has given the minute anatomy of *C.* (*Lomentaria*) *kalifornis*. The spores are wedge-shaped, contained in tufts in ceramidia borne on the branchlets. The tetraspores, 3-partite, are immersed in the branchlets.

Bibl. Harvey, *Mar. Alg.* pl. 13 B; *Phyc. Brit.* pl. 145, &c.; Grev. *Alg. Brit.* pl. 14; Nägeli, *Algen-systeme*, 246, pl. x. figs. 13–21.

CHYTRID'IUM, Braun.—A genus of Unicellular Algæ, perhaps allied to the Myxomycetes (Sachs), consisting of minute, globose or pyriform, usually colourless cells, operculate at the summit, with a root-like base, attached to Confervoid or allied plants, and penetrating their cell-walls. Zoospores very numerous, globular, with a single very long cilium.

C. olla (Pl. 5. fig. 7).

The commonest form is that of a somewhat ovate cell 1-5000 to 1-2000″ long, sessile by the thick end on the outside of the cell-wall of the plant it infests, and, according to Braun and Cohn, sending fine radical tubes into the interior; the cell-contents of the infested cell are usually found disorganized and discoloured. In

another form, distinguished by Pringsheim under the name of *Pythium*, the cells are globular and occur *in* the infested cells, pushing a long tubular neck out through the cell-wall. In both forms the contents of the *Chytridium*-cell are finally resolved into ciliated gonidia, which escape and swim about. In the external form, the cell often opens by a lid (like the androspore cells of ŒDOGONIUM); in the internal form the slender neck opens at the end. Braun has described no less than twenty-three of these obscure bodies, while Rabenhorst admits six species; and they have been observed by Cohn, who connects them with *Achlya*, considering them aquatic fungi. Carter has observed them in *Spirogyra*; and we have found both forms in and on the cells of CHLOROSPHÆRA. Braun and Cohn declare them to be really foreign bodies, that is, true parasites; but we are not clear on this point; they seem rather products of diseased protoplasm, if they be not modifications of the antheridial structures of some of the Confervoids.

BIBL.. Al. Braun, *Verjüngung &c. (Ray Transl.* 1853, 185); *Berl. Abhandl.* 1856, 2 (plates); *Ueb. Chytridium*, Berlin, 1856; *Alg. Unicell. Gen. Nov.* Leipsic, 1855; Bail, *Bot. Zeit.* xiii. 678; Cienkowski, *Bot. Zeit.* xv. 233; Carter, *Ann. Nat. Hist.* 2nd ser. xvii. 101, and xix. 259; Bary & Woronin, *Ber. Gesellsch. Freib.* 1863; Woronin, *Bot. Zeit.* 1868, 81; Nowakowski, *Cohn, Biol. d. Pfl.* i. 1, ii. 1877, 73, 201.

CIBO'TIUM, Kaulfuss. — A genus of Dicksonieæ (Polypodiaceous Ferns); with a bivalve indusium; now made a subgenus of *Dicksonia*.

BIBL. Hooker, *Syn. Fil.* 49.

Fig. 127.

Cibotium macrocarpum.
A pinnule with sori. Magnified 10 diameters.

CILIA (plural of *cilium*) of ANIMALS.— These are microscopic filaments attached by one end to the surfaces of various parts of animals, and exhibiting a vibratory or rotatory motion. They are usually rounded and broadest at the base, tapering towards the free end; sometimes they are flattened. Their length is very variable, having been estimated at 1-50,000 to 1-500″; probably 1-15,000 to 1-500″ would include most of them; in *Bacterium termo* they are 1-200,000″ in diameter (Dallinger). The larger size is attained by the cilia existing on the point or angle of the gills or branchial laminæ of the whelk (*Buccinum undatum*).

Numerous examples of animals furnished with cilia, showing their appearance when at rest, are figured in Pls. 30, 31, 32, 43, & 44. During life, and for some time after death, they are usually in constant motion, giving the parts of the field of the microscope in which they are situated a tremulous appearance when their motion is very rapid and the cilia are very minute. When they are large, as on the gills of the common sea-mussel (MYTILUS), especially when their motion is slackening, they are seen waving to and fro, or lashing the water, and producing in it strong currents, rendered visible by the motion of minute particles accidentally contained in the water. The motion is mostly uniform, or in one direction; occasionally, however, it has been observed to cease for a moment, and then to assume an opposite direction to that previously exhibited. During the motion, the whole filament is usually more or less curved; but in some instances among the Infusoria, the basal portion of the cilia remains rigid, whilst the terminal portion vibrates; under these circumstances the cilia are distinguished as flagelliform filaments. Sometimes the cilia move around an imaginary perpendicular axis, in a rotating direction.

Cilia are found in all the Vertebrata, and in the Invertebrata, excluding the Crustacea, Arachnida, and Insecta. We have, on two occasions, distinctly obtained ciliated epithelium, resembling that in Pl. 49. fig. 13, by wounding the bodies of the larvæ of garden-moths; but were unable to follow the observations. In Man, they spring from epithelial cells; the localities in which they are found are stated under EPITHELIUM.

The uses of the cilia are of two kinds: when the body to which they are attached is of no great bulk or specific gravity compared with that of the medium in which they reside, the cilia become organs of locomotion, as in the Rotatoria, Infusoria, the young Acalephæ, the ovum, &c.; but if the inertia of the body be too great to be

overcome by the feeble power of the cilia, they produce motion in the surrounding medium, as on the gills of fishes, of young reptiles, and of the Mollusca, the gill-tufts of the Annulata, and the various mucous surfaces of the Vertebrata upon which they exist, in which they favour respiration and excretion. By the same agency they also bring particles of food suspended in the medium towards the mouth. It need scarcely be remarked, that the motion of cilia must be stronger in one direction than the other, otherwise there could be no current.

The cause of the motion of cilia has long formed a subject for discussion; but it is still unknown. In some instances, as in the Infusoria, it appears to be voluntary. In certain cases it might be attributed to the action of a contractile amorphous tissue, such as that composing the *Amœbæ*. It would naturally be attributed to muscular agency; but no muscular tissue can be detected: in fact, cilia are quite structureless; moreover they are often of less breadth than the ultimate fibrillæ of muscle. Neither the most powerful poisons, as strychnine, prussic acid, opium and belladonna, nor electricity, produce any effect upon ciliary motion, provided the structure upon which the cilia are situated be not injured. It also lasts a long time after death, having been observed in the lower animals nineteen days after this occurrence, and when putrefaction was far advanced. The question has however, lost its interest in regard to its necessary dependence upon muscular action, because cilia are common among the lower plants, where this is out of the question.

The cilia and their motion may readily be observed in the common Rotatoria and Infusoria, or in a thin piece cut from the margin of the gills of the oyster; or still better, the sea-mussel; in the latter they form a most beautiful and interesting object. Fresh water almost immediately arrests the motion of the cilia in marine animals. In some cases, solution of potash excites the movement of animal-cilia after it has become languid.

The detection of the cilia is frequently of great importance, as the characters of Infusoria, &c. are often based upon their number and arrangement. The means are either indirect—as by the addition of moistened particles of colouring-matters, as indigo &c., to the living organisms, and watching for the movements of the particles—or direct, by examining the structures after the addition of solution of iodine, bichloride of mercury, or of osmic acid, or drying them at a gentle heat. Both methods should be adopted to check each other: for molecular movement has some resemblance to ciliary motion when feeble, although there is absence of a definite current; and fine hair-like Algæ or Fungi attached to aquatic organisms often resemble cilia, but are deficient in the motion.

See INFUSORIA; MEMBRANES, UNDULATING; and MOLECULAR MOTION.

BIBL. Purkinje & Valentin, *Comm. Phys. &c.*; Sharpey, *Todd's Cycl. of An. & Phys.* i. 606; Valentin, *Wagner's Handw. Phys. &c.* i. 484; Virchow, *Archiv*, vi. 133; Engelmann, *Jen. Zeitschr.* iv. 321; Roth, *Virchow's Arch.* xxxvii. 184; Häckel's *Biol. Stud.* 147; Frey, *Hist.* 1876, 173.

CILIA of VEGETABLES.—These minute vibratile threads, apparently of the same (unknown) nature as those of animals, are in all cases met with in connexion with the protoplasmic or nitrogenous structures of plants, the structure bearing the closest relation to animal organization. Cilia have as yet been found only in Flowerless Plants, viz. in all the higher or stem-forming Cryptogams, and in the Algæ among the Thallophytes. In the Marsileaceæ, Lycopodiaceæ, Ferns, Equisetaceæ, Mosses, Hepaticæ, and Characeæ, they are found upon the active filaments (spermatozoids) discharged from the antheridia. In the Algæ they occur upon the zoospores and sometimes upon the spermatozoids, and on the fully-developed plants of the family Volvocineæ. They have been stated to occur in certain other complete organisms, as in *Closterium*; but this statement we believe to be erroneous. Rigid filaments bearing some resemblance to cilia occur occasionally upon Diatomaceæ and Oscillatorieæ; but these are not vibratile organs. The mode of arrangement, &c. varies considerably among the cases above cited. In the spermatozoids of the Marsileaceæ, Lycopodiaceæ, Ferns, and Equisetaceæ, they are set in considerable number along a filament spirally or heliacally coiled (Pl. 40. fig. 34). In the Muscaceæ, Hepaticæ, and Characeæ, a pair of very long cilia is attached at one end of the filament (fig. 123, p. 162). In zoospores, either they occur in a pair at the apex, as in *Protococcus, Conferva, Cladophora, Codium*, &c., or there are four in the same situation, as in *Ulothrix, Chætophora, Ulva*, &c.; while the large zoospores

of *Œdogonium* bear a crown of vibratile cilia, and the great elliptical zoospore of *Vaucheria* is clothed with them over its whole surface. In the Volvocineæ, there is a pair of cilia attached, just like those of zoospores, to each member of the family of which the compound organism is made up; and these project through orifices in the common envelope, so as to render the perfect plant locomotive, while the cilia of ordinary zoospores disappear when they become encysted in a cellulose coat preparatory to germination. The spermatozoids of the Fucaceæ, and the zoospores produced in the sporangia of other Fucoids have a different arrangement of the cilia: there are always two; but they are attached on a reddish point on the side of the zoospore, not at its apex, and one of the cilia is directed forwards from the apex or beak, while the other trails behind like a kind of rudder.

The mode in which these transitory cilia are lost is variously stated: some authors think they are retracted into the protoplasm; from what we have seen, we believe they are thrown off entire. The cilia have the same chemical reactions as the protoplasmic substance generally, and are apparently processes of it; they are stained brown by iodine, which also stops their motion and renders them partly solid. The mode of detecting and observing cilia is given in the preceding article. Further particulars of individual cases will be found under the heads of the families and genera named above.

Bibl. Thuret, *Zoospores des Algues, &c., Ann. des Sc. Nat.* 3 sér. xiv. & xvi.; *Anthéridies des Fougères, Ann. Sc. N.* 3 sér. xi. 5; Hofmeister, *Vergleich. Untersuch. &c.*, Leipsic, 1851; Unger, *Die Pflanze im Momente der Thierwerdung*, 34, Vienna, 1843; Al. Braun, *Verjüngung, &c.* (*Ray Soc.* 1853); Cohn, *Protococcus pluvialis, Nova Acta A. L. C. C.* xxii. 735 (*Ray Soc.* 1853, 352); on *Stephanosphæra*, Siebold & Kölliker's *Zeitschr.* iv. 77 (*Ann. N. H.* 2 ser. x. 321); Henfrey (*Ferns*), *Linn. Tr.* xxi.; Focke, *Physiol. Studien*; Sachs, *Bot.* 244.

CILIARY PROCESSES. See Eye.

CILIOPHRYS, Cienk.—A genus of Actinophryina. *C. infusionum*, resembles *Act. sol*, but is much smaller; produces swarm-germs; in the scum of old infusions. (Cienkowski, *Schultze's Arch.* 1876, xii. 29.)

CIMEX, Linn. (Bug).—A genus of Insects, of the order Hemiptera, suborder Heteroptera, and family Cimicidæ.

Char. Antennæ four-jointed; labium three-jointed, the basal joint the longest; thorax sublunate, not transversely divided; abdomen much depressed, and more or less orbicular; elytra reduced to a pair of short, transverse, scale-like pieces; wings none; legs moderately long and slender; tarsi three-jointed.

C. lectularius (the bed-bug). Ferruginous-ochre; thorax deeply emarginate, its sides reflexed; abdomen suborbiculate, acute at the apex; third joint of antennæ longer than the fourth; rostrum inflected beneath the thorax; labrum short, broad, subovate, trigonate and ciliated.

The common bug has only three setæ, one stouter than the rest, and not toothed or serrated (Pl. 33. fig. 27 *a*), and two others extremely slender and very finely serrated near the ends (Pl. 33. fig. 27 *b*); these are about 1-20,000″ in breadth at the serrated portion (hence about the 1-20th part of the breadth of the lancets of the flea). The female is larger and more elongated than the male. The offensive odour is due to a liquid secreted by a pyriform reddish gland, situated in the centre of the metathorax, and opening between the hind legs. The eggs (Pl. 39. fig. 20) are white, elongate-oval, elegantly pitted, and terminated by a lid, which breaks off when the young escape. The latter are very small, white and transparent, and have a much broader head, with shorter and thicker antennæ than the mature insect. They undergo four moultings, and are eleven weeks in attaining their full size.

C. columbarius (Bug of the pigeon). Ferruginous-ochre; thorax deeply emarginate, sides reflexed; abdomen orbicular, subacute at the apex; third joint of antennæ slightly longer than the fourth; length about 1-5″.

C. hirundinis (Bug of the swallow). Fusco-ferruginous; thorax slightly emarginate; sides flat; abdomen ovate, subacute at apex; antennæ short, third and fourth joints nearly equal; length about 1-7″. Found in swallows' nests.

C. pipistrelli (Bug of the bat). Ferruginous-ochre, shining; thorax deeply emarginate, sides slightly reflexed; abdomen ovate, posteriorly attenuate; third joint of antennæ longer than the fourth; length 1-6″. On the common bat.

Mégnin maintains that these all belong to *C. lectularius*.

Bibl. De Geer, *Mém.* iii.; Duméril,

Cons. gén. s. l. Ins.; Westwood, *Intr.*; id. *Brit. Cycl. N. H.* i. 640; Jenyns, *Ann. N. H.* 1839, iii. 241; Curtis, *Brit. Entom.* xii. 569; Landois, *Sieb. & Köll. Zeitschr.* 1868 (*Anat.*) (*Qu. Mic. Jn.* 1868, 268); Mégnin, *Parasites*, 1880, 53; Leidy, *Jn. Mic. Soc.* 1878, i. 27.

CIN'CHONINE. Cinchonine is insoluble in ether. See ALKALOIDS.

BIBL. See CHEMISTRY.

CINCLID'IUM, Swartz.—A genus of Mniaceæ (operculate Mosses, arranged among the Acrocarpi from prevailing habit); of which one species, *C. stygium*, has been found in Yorkshire.

BIBL. Wilson, *Bryol. Brit.* 260; Berkeley, *Brit. Moss.* 181.

CINCLIDO'TUS, P. de B. See GUEMBELIA.

CINNAMON.—This consists of the inner part of the bark of *Cinnamomum Zeylanicum* (Lauraceæ); that of Cassia (*C. Cassia*), a coarser and less aromatic substance, is often substituted. These both consist of pitted liber-cells and oil-bearing parenchyma containing starch-granules, and are scarcely distinguishable by the microscope. This instrument, however, enables us to detect the fraudulent extraction of the aromatic oil, since heat applied for this purpose distorts and destroys the characters of the starch-granules. Ground Cinnamon and Cassia are adulterated with flours of different kinds, to increase bulk; these are detected by the characters of their starch-granules.

BIBL. Hassall, *Food &c.* 399.

CIONIS'TES, S. T. Wright.—A genus of Hydroid Polypes, fam. Podocorynidæ.

C. reticulata.

BIBL. Hincks, *Brit. Zooph.* 134; Wright, *Ann. N. H.* 1861, viii. 123 (fig. 1).

CIRCULAR CRYSTALS.—This term has been applied to the flattened groups of radiating crystalline needles formed by many salts and other crystalline substances. The term, however, is objectionable as tending to obscure their true nature. They form beautiful polarizing objects. Among the most interesting may be mentioned boracic acid, oxalurate of ammonia, salicine, and sulphate of cadmium. They are further noticed under their respective heads. Some of them are figured in Pl. 39. figs. 9–12.

It is interesting to remark that some of these circular crystals, as boracic acid, although belonging to a biaxial system, yet exhibit a single series of coloured rings.

See AMMONIA, OXALURATE OF, and POLARIZATION.

BIBL. Brewster, *Optics*, 1853, 269.

CIRCULATION in ANIMALS.—The movement in a temporarily or permanently definite to-and-fro direction, of the nutritive liquids of animals. We can only enumerate here the articles in which will be found a notice of the circulation, whether true or spurious, as occurring in the most easily accessible or interesting organisms; suffice it to say that circulation is produced either by the agency of muscular or other contractile tissue, or by the action of cilia. ASELLUS, ARACHNIDA, ENTOMOSTRACA, INFUSORIA, INSECTS (COCCINELLA, EPHEMERA, LARVÆ, LIBELLULIDÆ), RANA, TRITON.

CIRCULATION in PLANTS. See ROTATION and LATEX.

CIRRIPE'DIA or CIRRHOPODA.—An order of Crustacea. The barnacles or acorn-shells.

Char. Marine animals, in the adult state attached to other bodies; enclosed in a multivalved shell or in a coriaceous involucre furnished with calcareous points, the rudiments of a shell; eyes none in the adult state; six pairs of legs, each with a short fleshy peduncle, and two many-jointed horny cirri; mouth furnished with membranoso-corneous mandibles and maxillæ; tail terete, acuminate, reflexed between the legs; body not divided into segments, although there are indications of them in the form of transverse furrows on the dorsal surface. The six pairs of arms or legs which are situated on the ventral surface have each, supported on a short peduncle, two long thin incurved filaments, consisting of numerous joints, and covered with hairs. The animals protrude these filaments incessantly from the orifice of the shell, and retract them, whereby water for respiration and, with the water, food is brought into the shell. Cirripeds are usually hermaphrodite; sometimes dioecious.

The young Cirripeds, after leaving the ovum, resemble some of the Entomostraca, as *Cyclops* & *Cypris* (*Nauplius*-form). They are unattached, and possess eyes.

BIBL. Cuvier, *Mém. Mus. d'Hist. Nat.* 1815, ii.; Saint-Ange, *Mém. Cirrip.*; Coldstream, *Todd's Cyclop.*, art. *Cirrhopoda*; Burmeister, *Rankenfusser*; J. V. Thompson, *Zool. Researches*, and *Phil. Trans.* 1835, 355; Darwin, *Monog. Cirripedia* (*Ray So-*

ciety); Nicholson, *Zool.* 1878, 271; and the Bibl. of ANIMAL KINGDOM.

CLADI'NA, Nyl.—A subgenus of *Cladonia*.

C. sylvatica, amaurocræa, rangiferina, and *uncialis,* with their varieties, occur in Great Britain.

BIBL. Leighton, *Lich.-Fl. G. B.* 66.

CLADOBOT'RYUM, Nees. See DACTYLIUM.

CLADO'DEI.—A series of Lichens (fam. Lichenacei), comprising the tribes Bæomycei, Cladoniei, and Stereocaulei.

CLADO'DIUM, Brid.—A synonym of some species of BRYUM.

CLADOGRAM'MA, Ehr.—A genus of Diatomaceæ.

Char. Frustules disk-shaped, valves convex, with radiating irregularly forked lines; connecting-zone ring-like.

C. californicum, Ehr. (Pl. 51. fig. 14). *C. conicum,* Grev. Barbadoes deposit.

BIBL. Ehrenberg, *Mikróg.* pl. 33; Greville, *Mic. Trans.* 1865, 97.

CLADO'MONAS, Stein.—A genus of Flagellate Infusoria.

Char. Bodies ovate, with two equal anterior flagella, inserted in ends of a branched tubular zoary.

C. fruticulosa, fresh water.

BIBL. Kent, *Infus.* 284.

CLADONE'MA, Duj.—A genus of Hydroid Polypes, fam. Stauridiidæ.

C. radiatum. Devonshire coast.

BIBL. Hincks, *Brit. Zooph.* 61; Gosse, *Dev. Coast,* 257.

CLADONE'MA, Kt.—A genus of Flagellate Infusoria.

Char. Bodies pyriform, oblique in front, attached to a branched pedicle; flagella 1 long and 1 short, lateral.

C. laxa. Fresh water; on *Myriophyllum.*

BIBL. Kent, *Infus.* 264.

CLADO'NIA, Fée.—A genus of Lichenaceous Lichens, with a somewhat shrubby thallus, and fistular podetia, abundant on moors and heaths. It comprises the subgenera *Pycnothelia* and *Cladina.* The Reindeer Moss (*C. rangiferina*) is common in such localities. 26 other British species.

BIBL. Hook. *Brit. Fl.* ii. pt. 1. 238; *Engl. Bot.* pl. 173, 174, &c.; Leighton, *Lich.-Fl. G. B.* 52.

CLADONIE'I.—A tribe of Lichenaceous Lichens, series Cladodei.

Gen. *Cladonia* and *Pilophoron.*

CLADOPH'ORA, Kütz.—A genus of Confervaceæ (Confervoid Algæ), distinguished by the branched habit of the attached filaments. The *Cladophoræ* are interesting in many respects, in particular for the thick laminated structure of the cell-wall, the special projecting orifice in this by which the zoospores are discharged, the large number of the zoospores, and, lastly, by the favourable opportunity they afford of observing cell-division in the growth of the branched filaments. The filaments are composed of cylindrical cells attached end to end, from which the branches arise by the gradual protrusion of a cylindrical pouch near the upper end, which pouch, becoming shut off by a septum, forms the first cell of the branch. The cellulose wall acquires repeated layers of thickening with age; and longitudinal and transverse striæ may be detected in these by careful management. (See SPIRAL STRUCTURES.) The cellulose wall is lined by a layer of protoplasm (primordial utricle), upon the inside of which lies the chlorophyll, not, however, really imbedded in it, as it is often seen retracted from it in the centre of the cell. At certain periods, numerous starch-granules occur in the mass of chlorophyll; but these disappear when the latter is about to subdivide into zoospores. When this takes place, the whole mass of chlorophyll is contracted from the wall, and becomes broken up, by a kind of segmentation, into a very large number of 2- sometimes 4-ciliated zoospores (these sometimes occur in pairs, through imperfect division). The zoospores, which are produced in all the cells, are discharged through a special papilliform orifice in the cell-wall (Pl. 9. fig. 13); they have a distinct red spot. Numerous supposed species inhabit fresh, brackish, or sea-water in Britain; some are very common and abundant; but it is difficult to draw out differential characters, as the habit appears to be very variable. They are *Confervæ* of older authors.

C. glomerata, Dillw., is of a dark green colour, and grows commonly in long drawn-out skeins, in pure running water; but it seems to be identical with the rarer *C. ægagropila,* L., which forms dense balls 2 to 4″ in diameter, in lakes; while there is also a marine variety.

C. crispata, Sm., is perhaps not distinct; it forms yellowish or dull green strata, everywhere common in fresh water; frequent in brackish water. It is the same as *C. flavescens,* Roth. *C. fracta,* Fl. Dan., is probably a form of this.

The commonest marine species, which are often found in large quantities on the seashore, remarkable by their bright green tint, are *C. rupestris*, L., *lætevirens*, Dillw., *albida*, Huds., *lanosa*, Roth, *arcta*, Dillw., and *glaucescens*, Griff.; but some of these, and of the rarer, appear doubtful. The species require a careful study of fresh specimens in all stages. Kützing (*Sp. Alg.*) has made an inextricable mass of confusion of his species. Rabenhorst admits 8 species, with numerous varieties.

Bibl. Hassall, *Alg.* 213, pl. 65–67; Harvey, *Mar. Algæ*, 199, pl. 24 D; Thuret, *Rech. sur les Zoosp. &c.*, *Ann. Sc. Nat.* 3 sér. vol. xiv. 10, pl. 16; Al. Braun, *Verjüngung, &c.* (*Ray Soc.* 1853); Mohl, *Vermischte Schriften*, 362, pl. 13; Rabenhorst, *Flor. Alg.* iii. 333.

CLADOPH'YTUM, Leidy. — Probably the mycelium of a fungus. Found in the intestine of a *Iulus*.

Bibl. See Arthromitus.

CLADOSPO'RIUM, Link.—A genus of Dematiei (Hyphomycetous Fungi), stated by Tulasne to be conidiiferous forms of Sphæriacei. *Cl. herbarum* is one of the commonest moulds; it spreads over the surface as a dense or loose web of confluent tufts of microscopic filaments, straight or curved, more or less varicose, simple or branched; from these arise chains of spores, simple or with one or more septa, round, oval, or longish according to age, and finally becoming detached from one another.

Cl. herbarum, Lk. Tufts effused, at first green, then black; spores olive; very variable in habit. Everywhere common on decaying substances. Corda, *Ic. Fung.* iii. pl. 1. fig. 24; Fresenius, *Beitr. zur Myk.* pl. 3. fig. 29; *Dematium articulatum*, Sowerby, t. 400. fig. 8.

Cl. dendriticum, Wallr. On leaves of pear-trees and hawthorn. *C. pyrorum*, Berk. *Gardn. Chron.* 1848, 398. *Helminthosporium pyrorum*, Desmaz. No. 1051. *C. orbiculatum*, Desm. *Ann. Sc. Nat.* 3 sér. 275.

Cl. depressum, Berk. & Br. On living leaves of Angelica. *Ann. N. H.* 2 ser. vii. 97, pl. 5. fig. 8.

Cl. brachormium, Berk. & Br. On leaves of Fumitory. *Ibid.*

Cl. lignicolum, Corda. On dead wood. Corda, *Icon. Fung.* i. pl. 3. fig. 206.

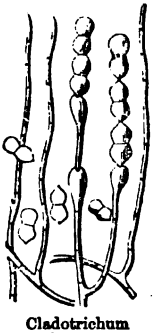
Cl. nodulosum, Corda. On stems of herbs. Corda, *Icon. Fung.* i. pl. 4. fig. 212.

CLADOSTE'PHUS, Ag.—A genus of Ectocarpaceæ (Fucoid Algæ), containing two common British species, *C. verticillatus* and *C. spongiosus*, which grow on rocks and stones, and form olive tufts a few inches high, composed of rigid irregularly branched cellular axes, clothed by whorls of short, mostly simple, articulated branches. Harvey states that the summer branches contain dark grains in their withered tips, and are deciduous, being replaced in winter by others which bear numerous lateral stalked spores. It is probable that these represent respectively the *trichosporangia* and *oosporangia* found in *Ectocarpus*, and that the so-called 'spores' emit zoospores. See Ectocarpus.

Bibl. Harvey, *Br. Mar. Alg.* pl. 9 A; *Phyc. Brit.* pl. 33 and 138.

CLADOTRICHUM, Corda.—A genus of Dematiei (Hyphomycetous Fungi), forming dark flocculent points, or confluent into powdery strata, on dead stumps, &c. The mycelium consists of rigid, much-branched, septate filaments, the upper joints swollen; the spores in chains together at the ends of branches, and bi-, triseptate, constricted in the middle.

Fig. 128.



Cladotrichum polysporum. Magn. 200 diam.

The species are probably states of Ascomycetous Fungi.

Cl. triseptatum, Berk. and Broome. Spores oblong, very obtuse, with three septa, and constricted opposite the middle septum. *Ann. Nat. Hist.* ser. 2, vii. p. 98, pl. 5. fig. 7. On a dead stump.

C. polysporum, Corda (fig. 128). Spores biseptate. Corda, *Icon. Fung.* iv. pl. 6. fig. 83; *Prachtflora Eur. Schimmelbild.* (*Polythrincium*, Fries, *Summ. Veg.*)

CLATHROCYS'TIS, Henfrey.—A genus of Palmellaceous Algæ, founded on *Microcystis* (*Polycystis*) *æruginosa* of Kützing. (Pl. 5. fig. 9.) The plants occur in autumn in myriads in freshwater ponds, giving the water a rich grass-green tint; the colour when dry is that of verdigris. Their appearance to the naked eye is that of a mass of green granules suspended in a colourless liquid. Under the microscope each granule is found to be a gelatinous body 1-50 to 1-15″ in diameter, in which are imbedded an infinite number of green

cells about 1-8000″ in diameter. The gelatinous masses expand by the multiplication of the green cells in the peripheral stratum, so that they become hollow sacs, the walls of which burst at various points and produce a clathrate structure. The processes of the network ultimately break asunder and commence a new development of the same kind.

Bibl. Henfrey, *Mic. Trans.* new ser. iv. 53, pl. 4. figs. 28–36; Currey, *Mic. Jn.* vi. 215; Kütz. *Tab. Phyc.* i. pl. 8; Duncan, *Jn. Mic. Soc.* 1880, iii. 17.

CLATHRULINA, Cien.—A genus of Actinophryina = a stalked *Actinophrys* contained in a fenestrated globular or pyriform carapace. The pseudopodia project through the fenestræ.

2 species or varieties.

Bibl. Cienkowski, *Archiv f. mik. Anat.* iii. p. 311; *Qu. Mic. Jn.* 1868, p. 31.

CLATHRUS, Mich.—A genus of Gasteromycetous Fungi, fam. Phalloidei.

C. cancellatus, fig. 273.

CLAVA, Gm.—A genus of marine Hydroid Polypes, fam. Clavidæ.

6 British species; height ¼ to 1½″.

C. multicornis. Rose-coloured, mouth white; 1¼″ high. Common on stones between tide-marks.

Bibl. Hincks, *Brit. Zooph.* p. 1.

CLAVATELLA, Hincks.—A genus of Hydroid Polypes, fam. Clavatellidæ.

C. prolifera, British.

Bibl. Hincks, *Brit. Zooph.* 70.

CLAVATELLIDÆ.—A family of Hydroid Polypes. 1 genus, *Clavatella.*

Bibl. Hincks, *Brit. Zooph.* 69.

CLAVA'TI.—A family of Hymenomycetous Fungi, characterized by bearing basidiospores covering the tip and sides of branched or simple club-shaped or variously cylindrical, compressed, or foliaceous receptacles. See Basidiospores, Hymenomycetes.

CLAVELI'NA, Sav.—A genus of Tunicate Mollusca, of the family Clavelinidæ, under which head the characters are given.

C. lepadiformis. Thorax a third of the length of the body, lines yellow; length ½ to ¾″. On rocks and stones at low water.

C. producta.—Thorax very short, as broad as long, abdomen very long.

C. pumilio. Nearly sessile and square.

Bibl. That of the family.

CLAVELI'NIDÆ.—A family of Tunicate Mollusca.

Distinguished by the separate bodies arising from a common creeping root-like fibre, and the mantle being united to the test at the orifices only.

These animals are very transparent, and well calculated for the study of the internal structure of the order. Genera:

Clavelina. Bodies oblong, erect; branchial and anal orifices without rays; thorax marked with coloured lines.

Perophora. Bodies roundish, compressed; thorax not marked with coloured lines.

Bibl. Forbes and Hanley, *Brit. Mollusca*, i. 25; Goose, *Mar. Zool.* i. 135; Lister, *Phil. Trans.* 1834; M.-Edwards, *Ascid. Comp.*

CLA'VIPES, Tulasne. — A genus of Sphæriacei (Ascomycetous Fungi), containing the plants which produce the *eryot* of rye and other grasses. These plants have recently been extricated from great confusion by Tulasne, who appears to have placed their history on a satisfactory basis.

The first sign of the attack upon the flower of a grass is the appearance of a white mould, sometimes accompanied by a honey-like secretion, consisting of minute cells, somewhat after the fashion of the yeast-plant; a swelling (*sphacelia*) then takes place upon the outside of the nascent pistil, which extends to the outer part of the substance of the wall of the ovary, growing with this until it forms a fungoid mass of the same shape as an ovary, but obliterating the cavity of the latter. At this time it is soft, white, grooved on the surface, and excavated by irregular cavities, which are connected with the external folds or grooves; the surfaces of these are all covered with parallel linear cells, like an hymenium; and from the extremities of these arise elongated ellipsoid or oval cells, about 1-5000″ in length. These become detached, and, when they are placed in water, germinate and emit filaments. These bodies are *spermatia*, *stylospores*, or perhaps *conidia*: they exhibit no motion in water, although they resemble the spermatia of some other fungi. At this time Tulasne calls the structure a *spermogonium.* At a certain epoch a viscid fluid exudes from the *sphacelia*, flowing over it and carrying about multitudes of the *spermatia* or *stylospores* (Pl. 26. fig. 17); but previously to this, a solid body, of a violet colour on the surface and white within, has originated at the base of the *spermogonium*, and it gradually grows and rises out of the paleæ of the flowers, forming the spur or *ergot.* This is not a metamorphosed seed, resulting from diseased

conditions, but a real new fungoid structure, the *Sclerotium* of DC. and others. When this *ergot* is sown in the earth like a seed, it produces a number of little pedicles surmounted by thickened heads, repesenting stalked *Sphæriæ* (Pl. 26. fig. 18); and on these heads are ultimately found fine points, which indicate the ostioles of little conceptacles (fig. 19). The walls of these conceptacles are lined with asci of elongate clavate form (figs. 20, 21), with linear, slightly clavate paraphyses. These bodies are the *Sphæria purpurea* of Fries, *System. Myc.*

Our space does not admit of further details; but it must be noted that very varied opinions have hitherto prevailed as to the nature of Ergot. Smith and E. Quekett, as also Leveillé, Phœbus, Mougeot, and Fée, regarded the ergot as a mere diseased form of the seed, associated with a parasitic Fungus (*Sphacelia*, Lév., Fée; *Ergotætia*, Quekett).

The *sphacelia* is often accompanied by a Mucedinous fungus, which is certainly *not* the result of germination of the stylospores as might be imagined, but a distinct plant.

Tulasne describes three species:

C. purpurea, Tul. (Pl. 26. figs. 18–22). The ergot of grasses = *Sphæria entomorrhiza*, Schum.; *Sphæria* (*Cordyceps*) *purpurea*, Fries; *Kentrosporium mitratum*, Wallr.; *Sphæropus fungorum*, Guibourt: *Cordyliceps purpurea*, Tulasne. On the flowers of Grasses, such as rye, wheat, oats, and numerous pasture grasses.

C. microcephala, Tul. *Kentrosporium microcephalum* Wallr.; *Sphæria microcephala*, Wallr.; *Sphæria acus*, Trog.; *Cordyceps purpurea*, var. *acus*, Desm. On *Phragmites communis* and *Molinia cærulea*.

C. nigricans, Tul. On species of *Scirpus*.

Bibl. Tulasne, *Ann. des Sc. Nat.* 3 sér. xx. 5–43, pls. 1–4, where all the previous literature is reviewed; Quekett, *Linn. Tr.* 1839; Cesati, *Bot. Zeit.* 1855, 74; Currey, *Qu. Mic. Jn.* 132; Bonorden, *Bot. Zeit.* 1858, 97; Lindley, *Veg. Kingd.*; Kühn, *Mitt. landw. Inst. Halle*, i. 1863; Sachs, *Bot.* 381.

CLA'VIDÆ. — A family of Hydroid Polypes.

Char. Polypes claviform or fusiform, with scattered tentacula. Genera:

Polypes stalked.	
Stem simple.....	*Tubiclava.*
Stem much branched.....	*Cordylophora.*
Polypes sessile.	
Tentacles few	*Turris.*
Tentacles very numerous ...	*Clava.*

Bibl. Hincks, *Hydr. Zooph.* p. 1.

CLAVULA'RIA, Grev.—A genus of Diatomaceæ.

Char. Frustules free, linear, with numerous transverse pseudo-dissepiments, interrupted by a central smooth external plate. Valves with a central inflation, and a longitudinal row of short subcapitate processes.

C. barbadensis (Pl. 51. fig. 33). In Barbadoes deposit.

Bibl. Greville, *Micr. Trans.* 1865, p. 24.

CLAVULI'NA, D'Orb. — A modified *Valvulina*, in which the triserial arrangement of the chambers (three in one whorl of the spire) has passed into a uniserial or linear row, making altogether a *claviform* shell.

The long dimorphous *Textulariæ*, having a similar shape, have been recorded as *Clavulinæ*; but the absence of the septal *valve* distinguishes them.

C. parisiensis (Pl. 23. fig. 51.) is a neat form, with a marked distinction of triserial and uniserial growth. These long dimorphous *Valvulinæ* are common in some Tertiary deposits, and in the Indian and Australian seas.

Bibl. Parker and Jones, *Ann. N. H.* ser. 3, v. 467–469; Carpenter, *For.* 147, 193.

CLEISTOCAR'PI, (Closed-fruited, *i. e.* inoperculate).—An artificial division of the Mosses.

In this group, the capsule bursts irregularly. It contains the families Bruchiaceæ, Phascaceæ, and Ephemereæ.

See Mosses.

CLETO'DES, Brady.—A genus of Copepoda (Entomostraca). 4 species. In dredgings on the north British coasts.

Bibl. Brady, *Copepoda* (*Ray Soc.*).

CLIMACAM'MINA, Brady.—An arenaceous, coarse Textularian Foraminifer, of bigenerine growth; with labyrinthic structure inside the chambers, and cribriform aperture. Fossil in the Mountain-limestone of Britain and Russia; not rare.

Bibl. H. B. Brady, *Monog. Carb. Foram., Pal. Soc.* 1876, 67.

CLIMA'CIUM, W. and Mohr.—A genus of Mosses, synonymous with *Hypnum* (*dendroides*).

Bibl. Wilson, *Bryol. Brit.* p. 325; Berkeley, *Brit. Moss.* p. 140.

CLIMACONE'IS, Grun.—A genus of Diatomaceæ.

Char. Frustules bacillar, free (?), with

2 scalariform dissepiments; valves striato-punctate, costæ none.

C. Lorenzii. Valves linear-lanceolate, swollen at the ends and the middle. In the Adriatic.

Bibl. Grunow, *Wien. Verhandl.* 1862, 421, pl. 8. fig. 7.

CLIMACOSPHE'NIA, Ehr.—A genus of Diatomaceæ.

Char. Frustules cuneate, stipitate, divided into loculi by transverse septa; valves obovato-lanceolate, with moniliform vittæ in the front view. Marine; not British.

C. australis. Very shortly stipitate; sides of the valves not (very faintly?) striated.

On Algæ from New Holland and South Africa.

C. moniligera (Pl. 25. fig. 9). Stipitate, sides of the valves transversely striated (*a*, front view; *b*, side view).

In the Gulf of Mexico.

Rabenhorst enumerates 6 species.

Bibl. Ehrenb. *Abh. Berl. Ak.* 1841, 401; id. *Ber.* 1843; Kützing, *Bacillar.* 123, and *Sp. Alg.* 114; Rabenhorst, *Alg.* i. 299.

CLIMACOS'TOMUM, Stein, = *Spirostomum virens*, Ehr.

CLI'ONA, Grant.—A genus of marine Sponges. By means of the spicula imbedded in their surface, they burrow into rocks, shells, and stones.

Bibl. Gosse, *Mar. Zool.* i. 5; Hancock, *Ann. Nat. Hist.* 1849, i. 321; Bowerbank, *Brit. Spog.* ii. p. 212.

CLONOS'TACHYS, Corda.—A genus of Mucedines (Hyphomycetous Fungi), apparently not distinct from Botrytis.

C. araucaria (fig. 347) has been found in England.

Bibl. Corda, *Prachtfl. europ. Schimmelbild.* pl. 15; Currey, *Qu. Mic. Jn.* v. 126.

CLOSTE'RIUM, Nitzsch.—A genus of Desmidiaceæ (Confervoid Algæ).

Char. Cells single, elongated, attenuated towards each end, entire; mostly curved lunately or arcuate; junction of the segments marked by a pale transverse band. Endochrome green.

This beautiful genus is of great interest to the scientific microscopic observer. Many of the species are very common, so that scarcely a drop can be taken from the bottom of a clear pool without some of them being contained in it.

Each cell is composed of two equal portions, uniting at a transverse line occupying the middle of the cell. The endochrome exhibits longitudinal bands (Pl. 14. fig. 40), the number varying in different species, of a darker green than the rest of the endochrome (Pl. 14. figs. 40, 41, 43). A number of chlorophyll-vesicles are frequently visible in the endochrome, sometimes scattered irregularly, at others arranged in longitudinal series (Pl. 14. fig. 43); at certain periods these contain starch-granules.

The green endochrome is separated from the cell-wall by a stratum of colourless protoplasm which occupies a bluntly triangular space at each extremity. In many cases the protoplasm at these ends exhibits a large roundish vacuole, in which a number of minute granules are contained, often in active motion. Similar granules are visible in the marginal line of protoplasm, which exhibits a distinct circulation, requiring a power of about 400 to show it clearly. Focke, Osborne, and others have described cilia inside the cell-wall, and attributed the circulation to their action; but this is erroneous. The protoplasm appears to flow up over the interior of the cell-wall on all sides, from the centre to the extremity, then to turn round past the vacuole, and return over the surface of the green endochrome parallel to the upward course. Wills states that the vacuoles at the ends of the cells are contractile vesicles, connected with the flow of the currents.

The *Closteria* are reproduced in various ways. The individuals divide, like the rest of the Desmidiaceæ, the separation taking place transversely in the situation of the transparent space, where two new half-cells become developed, subsequently separating. As these new 'halves' are often very small at the epoch of separation, specimens occur with the two portions very unequal.

Another mode of reproduction is by conjugation. In this, a pair of individuals become united somewhat in the same way as in the Zygnemaceæ; ordinarily the individuals conjugate by the convex side. The process is this:—The outer membranes of the parents split circularly in the situation of the central transverse space; a delicate internal membrane is protruded from each as a sac, and these meet and coalesce. Sometimes the sacs are in pairs from each parent-cell. (See Conjugation.) When the cross process is complete, the contents of both parent-cells pass into it and become collected into a globular or squarish cell or zygospore (Pl. 14. figs. 42 & 46.). Different statements are made with regard to the ultimate history of this; and it is

probably variable. Morren states that it becomes a moving gonidium, while most authors state that it becomes a resting-spore with firm membranous coate. Again, Morren assumes the segmentation of the green contents of this spore or gonidium into a number of portions, each of which becomes a perfect individual. Focke gives a figure which seems to bear out this statement; and it would find an analogy in the mode of reproduction by active gonidia in *Pediastrum*, described by Caspary and Braun. (See PEDIASTRUM.) Focke also figures a condition of *Closterium Lunula*, in which the whole of the green contents of an individual cell had become retracted from the walls, and converted into a number of green globular bodies, with proper coats, resembling the resting spores found under certain conditions in many filamentous Algæ. (See ŒDOGONIUM and SPIROGYRA.)

The *Closteria* are capable of fixing themselves by one extremity to foreign bodies, and Ehrenberg asserted the existence of a foot-like organ; but no such structure seems to exist. The individuals also possess a power of moving in water, but the nature of this is inexplicable at present. The segments of the outer membrane separate from each other when their contents decay, and often when they are dried. The membrane is coloured blue by sulphuric acid and iodine (cellulose); in its natural condition it often has a reddish tint, especially towards the ends.

Rabenhorst describes 52 species, with numerous varieties.

Analysis of ordinary British species:—

1.	Cell suddenly narrowed at the ends into a conical point	*attenuatum*, l. 1-57″.
	Cell not suddenly narrowed	2
2.	Cell striated, tapering into a beak at ends, lower margin prominent at middle	3
	Cell very minute, beaked, straight, not striated, nor lower margin prominent at middle	*Griffithii**, l. 1-300 to 1-450″.
	Cell not beaked; if striated, lower margin not prominent at middle	6
3.	Beaks setaceous, as long as or longer than body	4
	Beaks linear, much shorter than body	5
4.	Beaks much longer than body	*setaceum* †, l. 1-116″.
	Beaks about as long as body	*rostratum*, l. 1-169″.
5.	Cells much inflated at middle, rapidly tapering at ends	*Ralfsii*, l. 1-79″.
	Cells slightly inflated at middle, gradually tapering at ends	*lineatum*, l. 1-48″.
6.	Cell minute, acicular; sporangium cruciform	7
	Cell not acicular; sporangium orbicular	8
7.	Ends obtuse	*cornu*, l. 1-140″.
	Ends acute	*acutum*, l. 1-177″.
8.	Cell semilunate or semilanceolate, lower margin inclined upwards at ends	9
	Cell with either truncate ends, or lower margin inclined downwards at ends	12
9.	Vesicles numerous, scattered	*lunula* *, l. 1-60″.
	Vesicles in a longitudinal row	10
10.	Ends of cell slightly curved upwards; longitudinal striæ distinct	*turgidum*, l. 1-39″.
	Ends of cell straight; striæ none or indistinct	11
11.	Cell linear-lanceolate; ends conical, obtuse	*acerosum* †, l. 1-70 to 1-58″.
	Cell semilanceolate; ends subacute	*lanceolatum*, l. 1-64″.
12.	Cell not striated, crescent-shaped	13
	Cell either not crescent-shaped, or else distinctly striated	17
13.	Vesicles numerous, scattered	*Ehrenbergii*, l. 1-68″.
	Vesicles in longitudinal row	14
	Empty cell colourless, ends rounded	15
14.	Empty cell usually reddish, ends subacate	16
15.	Lower margin of cell inflated at middle	*moniliferum* ‡, l. 1-75 to 1-60″.
	Cell not inflated at middle	*Jenneri*, l. 1-280″.
16.	Cell inflated at middle	*Leibleinii*, l. 1-90 to 1-60″.
	Cell slender, not inflated at middle	*Dianæ*, l. 1-140″.
17.	Lower margin of cell inclined upwards at truncate ends; longitudinal striæ none or indistinct	*didymotocum* §, l. 1-65″.
	Ends of cell inclined downwards; striæ distinct	18
18.	Longitudinal striæ 3 to 7, prominent	19
	Longitudinal striæ numerous, fine	20
19.	Cell semiluna or crescent-shaped	*costatum*, l. 1-75″.
	Cell linear	*angustatum*, l. 1-60″.
20.	Cell narrowly linear, nearly straight	*juncidum*, l. 69 to 1-111″.
	Cell tapering, curved	21
21.	Longitudinal striæ crowded, sutures 1 to 3	*striolatum*, l. 1-80 to 1-68″.
	Longitudinal striæ not crowded sutures usually more than 3	*intermedium*, l. 1-77 to 1-54″.

BIBL. Meneghini, *Syn. Desmid.*, *Linnæa*, xiv. 201; Ehrenb. *Infus.*; Ralfs, *Brit. Desmidieæ*; Smith, *Ann. N. H.* 1850, v. 1; Brébisson, *Alg. Falaise, & Conjugatæ*; Kützing, *Spec. Alg.* 163; Berkeley, *Ann. N. H.* 2 ser. xiii. 256; Braun, *Rejuv.* (*Ray Soc.* 1853, 289, 292); Morren, *Ann. Sc. Nat.* 2 sér. v. 257; Focke, *Physiol. Stud.* 1847; Osborne, *Qu. Mic. Jn.* iii. 54; Henfrey,

* Pl. 14. figs. 57 & 58.
† Pl. 14. figs. 45 & 46 (Conjugation).

* Pl. 14. fig. 40.
† Pl. 14. figs. 41 & 42 (Conjugation).
‡ Pl. 14. fig. 43.
§ Pl. 14. fig. 44.

Ann. N. H. 3 ser. i. 419; Pritchard, *Infus.* 746; Rabenhorst, *Flor. Alg.* iii. 123; Wills, *Jn. Mic. Soc.* 1880, iii. 845.

CLYPEAS'TER, Lamk.—A genus of Echinodermata.

The hairs or spines springing from the shell are beautiful microscopic objects.

CLY'TIA, Lam.—A genus of Hydroid Polypes, fam. Campanulariidæ.

1 Brit. species: *C. Johnstoni*=*Campanularia volubilis.*

Bibl. Hincks, *Hyd. Zooph.* p. 140.

CNEMIDA'RIA, Presl.—A genus of Cyatheæ (Polypodiaceous Ferns). Now consolidated with Hemitelia.

Fig. 129.

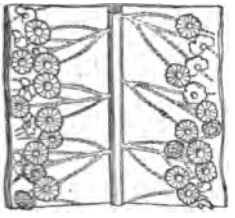


Fig. 130.

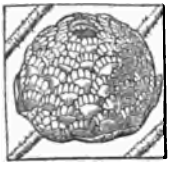


Fig. 131.

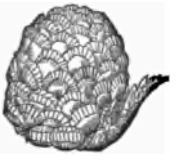


Fig. 132.

C. (Hemitelia) horrida.

Fig. 129. Fragment of a pinnule, the sori covered by indusia. Magnified 5 diameters.
Fig. 130. A sorus with indusium destroyed.
Fig. 131. The same, side view, showing the fragment of the indusium at the base.
Fig. 132. Vertical section of a sorus.

Figs. 130–132 magnified 25 diameters.

COAL.—This substance, although classed from its mode of occurrence in nature in the mineral kingdom, is in all cases of vegetable origin. The degree, however, in which traces of organic structure may be detected in it varies extremely. Coal may be either tolerably *pure*, containing but slight admixture of earthy matters, or it may contain large quantities of earthy substance, and pass gradually into a carbonaceous impregnation of an earthy basis, as in the various modifications of bituminous shales. In the next place the degree of metamorphosis of the vegetable matter may be equally varied, so that we have it still retaining its structure very evidently, as in *lignites*, &c., or with the structure greatly destroyed, or altogether lost, as in much ordinary coal and anthracite, which however are apparently of somewhat different origin from the more recent lignites. Some of the old coal-beds appear to have been formed from deposits analogous to our peat-bogs, and hence naturally consist in great part of vegetables whose remains soon become undistinguishable; but that arborescent vegetation was also present and contributed to form the coal, is proved by the detection of woody structure somewhat like that of the Coniferæ in certain specimens of coal. Sometimes the woody structure is even evident to the naked eye, in a charcoal-like appearance of the fractured surface or bed-planes of coal. In many lignites the coal consists of trunks of trees converted into coal without much alteration of the appearance of *texture* of the wood; and in these the structure is very readily made out by means of the microscope. Some old coal is largely or entirely composed of sporangia of Lycopodiaceous or Lepidodendroid plants, cemented together by a brown substance derived from the decomposition of the tissues of the coal-forming plants. It would be out of place here to enter upon the geological and chemical questions connected with coal; the object of applying the microscope to it is to ascertain the existence or absence of organic structure. For this purpose various methods are employed. That most in use is the preparation of exceedingly thin slices in the manner usually adopted for fossil structures, but the brittle and opaque character of coal opposes great difficulties here. Traces of structure may be made out in some cases by grinding coal to fine powder and examining the fragments; but this plan is very unsatisfactory. A third method is to burn the coal to a white ash, and examine this under the microscope: it often exhibits perfect skeletons of vegetable cells, but these are very fragile, and require great care in their management. By imbuing them very cautiously with turpentine and Canada balsam, and placing on the covering glass when the latter has become rather firm, permanent preparations may often be obtained. Schulze recommends boiling in nitric acid before incinerating the coal. The method which has been attended with most success in our

hands is as follows. The coal is macerated for about a week in a solution of carbonate of potash; at the end of that time it is possible to cut tolerably thin slices with a razor. These slices are then placed in a watch-glass with strong nitric acid, covered and gently heated; they soon turn brownish, then yellow, when the process must be arrested by dropping the whole into a saucer of cold water, or else the coal would be dissolved. The slices thus treated appear of a darkish amber colour, very transparent, and exhibit the structure, when existing, most clearly. We have obtained longitudinal and transverse sections of Coniferous wood from various coals in this way; although this structure is most abundant in lignites. The specimens are best preserved in glycerine, in cells; for spirit renders them opaque, and even Canada balsam has the same defect. Schulze states that he has produced the cellulose reaction with iodine, in coal treated with nitric acid and chlorate of potash.

The proper identification of vegetable structures in coal must of course depend upon a sufficient knowledge of the characters of vegetable tissues and organisms being possessed by the observer.

BIBL. Witham, *Fossil Vegetables*, Edinb. 1833; Link, *Abh. Berl. Akad.* 1838; 34; Göppert, *Preisschrift üb. Steinkohlen*, Leiden, 1848; Lindley and Hutton, *Fossil Fl.*; Schleiden and Schmidt, *Geognost. Verhältn. des Saalthales*, Leipzig, 1846; Ehrenberg and Schulze, *Berlin Ber.* 1844; F. Schulze, *ibid.* 1855; *Ann. N. H.* xvi. p. 69; Bailey (*Anthracite*), *Ann. N. H.* xviii. 67; Unger, *Gen. et Spec. Plant. Foss.* 1850; Carruthers, *Mn. Mic. Jn.* ii. 177, 225, iii. 144; Williamson, *ibid.* ii. 66; Lyell, *Princip. of Geol.*; Huxley, *Contemp. Rev.* 1867; Dawson, *Acadian Geol.* 1868; *Mn. Mic. Jn.* 1870, 319; Williamson, *Phil. Proc. & Trans.* 1873 *et seq.*; Zirkel, *Mineralien*, 1873, 257; Reinsch, *Steinkohle*, 1881.

COBÆ'A, Cuv.—A climbing Dicotyledonous plant, of the Nat. Order Polemoniaceæ, common in cultivation, remarkable for the curious pyriform cells upon its seeds, containing a spiral fibre (Pl. 28. fig. 20). See SPIRAL STRUCTURES.

COCCID'IUM.—A form of fructification in the FLORIDEÆ.

COCCINEL'LA, Linn. (Lady-bird).—A genus of Insects, of the order Coleoptera, and family Coccinellidæ.

C. septempunctata, the common lady-bird. This insect exhibits the circulation through the elytra. If one of these is separated from the body without being detached, and arranged in such a manner that it may be viewed as a transparent object, slow and uniform continuous currents, one ascending and the other descending, will be seen between the laminæ of which the elytrum consists. On dividing the latter an amber transparent liquid containing colourless globules escapes.

BIBL. Nicolet, *Ann. Sc. Nat.* 3 sér. vii.; Westwood, *Introd. &c.*; Curtis, *Brit. Ent.* 208; Stephens, *Brit. Entom.*; Calver, *Käferbuch*, 690.

COCCOBACTE'RIA.—A term employed by Billroth to designate the Schizomycetous Bacteria and their allies. The author regards the globular forms *Coccos*, and the rod-like forms *Bacterium* and *Bacillus*, as belonging to a single organism; the former arising from the division and spore-formation of the latter, and the two forms being often found in the same filament or zoogloea-form; the whole constituting his *Coccobacteria septica*. Billroth gives new names to the various forms, and regards them as colourless parallel states of many of the lower Algæ. The occurrence of these organisms in various liquids, and their influence in the production of decomposition and disease, are fully treated in his elaborate and well-illustrated treatise. (Billroth, *Coccobacteria septica*, 1874.)

COCCOCAR'PEÆ (Algæ). See CRYPTONEMIACEÆ.

COCCOCAR'PIA, Pers.—A small genus of mostly tropical Lichens, now united with *Pannaria*.

C. (*P.*) *plumbea*, Lightf., is British, and has the thallus orbicular, livido-cinerascent, adnate; apothecia reddish-brown; spores 8, simple.

BIBL. Lightfoot, *Fl. Scot.* ii. 826, pl. 26; Leighton, *Lich.-Fl. G. B.* 154.

COCCOCHLO'RIS, Sprengel (*Palmoglœa*, Kütz).—A genus of Palmellaceæ (Confervoid Algæ), consisting of green microscopic cells, oval or globular, imbedded in a gelatinous matrix, which is at first definite in form (thus differing from *Palmella*), subsequently effused and shapeless. The green cells are vesicles, filled with granular colouring-matter (chlorophyll) when in active vegetation. They multiply by division; and besides this, some of them grow much larger than the rest, and their contents are converted into a number of cells;

these large cells become free from the general frond, and lay the foundation of new ones, originally of definite form, which increase in size by the division of the individuals within a persistent gelatinous investment. Brébisson, Ralfs, and Braun describe a process of conjugation in *C. Brebissonii* (Pl. 7. fig. 6). Two cells come into contact, and their membranes become fused; the intermingled contents then undergo a metamorphosis, brownish oil-globules replacing the chlorophyll; and the 'spore-cell' thus produced passes through a period of rest before resuming its vegetative development. Thwaites states that the slender filamentous bodies sometimes found in the frond are part of the organization of the plant (see PALMELLACEÆ). Several British species are described:

C. protuberans, Spreng. Frond green, irregularly lobed, spreading on the ground, cells elliptical, about 1-3000″, enlarged vesicles 1-500 to 1-1000″. Hassall, *Algæ*, pl. 76. fig. 7, pl. 82. figs. 6–10; *Palmella protuberans*, Grev. *Sc. Crypt. Fl.* pl. 243. fig. 1.

C. muscicola, Meneghini. Hassall, *l. c.* pl. 78. figs. 3 *a*, 3 *b*.

C. hyalina, Menegh. Fresh water. Hass. *l. c.* pl. 78. figs. 2 *a*, 2 *b*.

C. depressa, Menegh. Hass. *l. c.* pl. 78. figs. 4 *a*, 4 *b*.

C. Mooreana. Hass. *l. c.* pl. 78. 1 *a*, 1 *b*.

C. rivularis. Hass. *l. c.* pl. 78. 6 *a b*.

C. Grevillei, Hass. Frond minute, densely crowded, globose or somewhat lobed, green. In healthy moist situations, frequent. Hass. *l. c.* pl. 78. figs. 7 *a b* and 8; *Palmella brotryoides*, Grev. *Sc. Crypt. Fl.* pl. 243. fig. 2.

The plants are not yet satisfactorily understood; the relations to *Palmella* and *Glœocapsa* are confused.

BIBL. Meneghini, *Monogr. Nostoch.*; Kützing, *Phyc. gen.*; Braun, *Rejuv.* (*Ray Soc.* 1853), as *Palmoglœa*; Thwaites, *Ann. N. H.* ser. 2, vol. ii. 312 (as *Palmella*); Nägeli, *Einzell. Algen*, 1849; Rabenhorst, *Fl. Alg.* ii. 67.

COC'COLITHE or COCCOLITE.—A term applied to the granular varieties of pyroxene (native silicate of magnesia, with metallic silicates).

COC'COLITHS.—The name given by Huxley in 1858, to minute oval or round, calcareous bodies (Pl. 23. fig. 56 *b*), 1-900″ and less in size, abounding in the Atlantic ooze, either loose or attached to small lumps of protoplasm ('Coccospheres,' Wallich). Two forms were recognized, *Discolithi* and *Cyatholithi*. Similar microliths had been noticed as forming a large proportion of white chalk by Ehrenberg, Reade, and Sorby. Wallich also found them in the North Atlantic, in chalk, in tropical floating Coccospheres, and in dredgings in the English Channel. Haeckel subsequently found them in the harbour of Lanzarote, Carter in the English Channel, and Guembel in limestones of all ages.

Ehrenberg termed these little bodies 'Morpholites of the chalk,' and regarded them, like his 'crystalloids,' as due to the rearrangement of calcareous particles. Sorby, Huxley, Wallich, and Haeckel differ in opinion as to whether they exist independently or not of Coccospheres. Carter ascribes them to an Alga (*Melobesia*).

Coccoliths of either kind, treated with dilute acid, leave a soft flexible cast or film, which is coloured yellow by iodine, pale red with carmine, red by Millon's test, and is dissolved by alkalies.

BIBL. Ehrenberg, *Monatsber. Ak. Berlin*, 1836; *Pogg. Ann.* 1836, xxxix. 101; *Abhandl. Ak. Berlin*, 1838, 67; *N. Jahrb. f. Min.* 1840, 680; *Journ. prakt. Chemie*, 1840, xxi. 95; *Edin. N. Phil. Journ.* 1841, xxx. 353; *Mikrogeologie*, 1854; Reade, *Mantell's Wonders of Geology*, 7th ed. ii. 953; Huxley, *Deep-sea Soundings, &c.* 1858, 64; *Qu. Mic. Journ.* 1868, 203; Wallich, *Life at Great Depths*, 1860, 13; *Ann. Nat. Hist.* 1861, vii. 396, *ibid.* viii. 52; Sorby, *Proc. Lit. Phil. Soc. Sheffield*, 1860; *Ann. N. H.* Sept. 1861; Haeckel, *Jen. Zeitschr.* v. 1870; Guembel, *Jahrb. Münch.* 1870, 753; Carter, *Ann. N. H.* 1871, vii. 184.

COCCONE'IS, Ehr.—A genus of Diatomaceæ.

Char. Frustules single, depressed, adnate; valves elliptical, one of them with a median line and central nodule.

The valves are mostly covered with dots (minute depressions), appearing like lines under a low power.

The upper valve differs from the adnate one in not being furnished with the central nodule: under a low power it appears to have a median line as well as the adnate valve; but this, in some at least, arises from the dots or markings at this part being more closely in contact than elsewhere.

The frustules are often found densely incrusting filamentous Algæ.

C. pediculus (Pl. 16. fig. 17). Frustules very slightly arched (front view); valves

elliptical, striæ longitudinal, faint; length 1-1200 to 1-700″; aquatic.

C. placentula. Frustules flat; valves elliptical; striæ longitudinal, faint; length 1-760″; fresh water, common.

C. scutellum (Pl. 16. fig. 18). Frustules dorsally convex; valves ovato-elliptical, striæ transverse or slightly curved; length 1-700″; marine. *β.* Nodule dilated into a stauros.

C. Thwaitesii (*Achnanthidium flexellum*, Brébiss., Kütz.). Ends of valves slightly produced; fresh water, length 1-900″.

C. Grevillii. Oval, with transverse canaliculi; marine.

C. diaphana. Elliptical, diaphanous; marine.

Rabenhorst describes 37 European species, with numerous varieties; and enumerates 37 foreign species (with the references).

Bibl. Ehrenb. *Infus.*; Kützing, *Bacill.*, and *Sp. Alg.* 50; Smith, *Brit. Diat.* i. 21; Rabenhorst, *Flor. Alg.* i. 98; Greville, *Micr. Tr.* 1864, 9, 1865, 33, 1866, 126.

COCCONE'MA, Ehr.—A genus of Diatomaceæ.

Char. Frustules stipitate, navicular, somewhat arched (side view); valves with a submedian line, with central and terminal nodules (=stipitate *Cymbellæ*). Fresh water.

Valves transversely striated, the striæ being resolvable into dots.

7 European species (Rab.).

C. lanceolatum (Pl. 16. figs. 19 & 20). Front view of frustules lanceolate, truncate at the ends; valves semilanceolate, very slightly inflated at the centre of the concave margin; length 1-150″. Common. Stipes dichotomous, jointed.

C. cymbiforme. Scarcely distinct from the last (Sm.); stipules filiform, obsolete, interwoven into a gelatinous mass; length 1-330″.

C. cistula. Front view elliptic-oblong, obtuse; valves inflated on concave margin; stipes elongate, filiform, simple or subracemose; length 1-450″; common.

C. parvum (Sm.). Several other foreign species.

Bibl. Ehr. *Inf.*; Smith, *Br. Diat.* i. 75; Kütz. *Bacill.*, and *Sp. Alg.* 59.

COCCOSPHÆ'RA, Perty.—An obscure genus of Infusoria (Algæ?), consisting of very minute spherical granules, with a black, brown, or red nucleus, aggregated into irregular revolving lumps, 1-400″ in diam.; they exhibit slow motion. In turf-pits &c.

Bibl. Perty, *Kleinst. Lebens.* 1852, 104.

COCCOSPHERES.—The name given by Wallich to minute lumps of colourless protoplasm, found in deep-sea ooze, and floating in the tropics. He describes them as spherical or multilobed, from 1-5000 to 1-830″ in size, imitating in shape *Orbulina*, *Nodosaria*, *Textilaria*, *Rotalia*, and *Globigerina*, and coated with numerous oval Coccoliths (Pl. 23. fig. 56 *a*).

From the Atlantic ooze, also, Huxley describes minute granular colourless sarcodic bodies as Coccospheres, 1-4500 to 1-1700″ in diameter, some having Coccoliths on or in them; and he distinguishes (1) the compact, hollow, flattened sphæroids with an envelope, and (2) loose (1-4500 to 1-760″). The corpuscles are free, touching or overlapping, 1-11000 to 1-4500″ in breadth, sometimes mingled with Coccoliths (1-11000 to 1-1600″).

Bibl. That of Coccoliths, and Wallich, *Ann. N. H.* 1877, xix. 342 (figs.).

COCCUDI'NA, Duj.—A genus of Infusoria, of the family Plœsconina.

Char. Body oval, depressed or almost discoid, often slightly sinuous at the margin; convex, furrowed or granular and glabrous above; concave beneath, and furnished with vibratile cilia and cirri or corniculate appendages, serving as legs; no mouth.

The species of this genus known to Ehrenberg are arranged among his Oxytrichina and Euplota.

C. costata (Pl. 50. fig. 3). Body obliquely narrowed and sinuous in front, convex and furrowed above, or with from five to six very projecting tubercular ribs; appendages grouped at the two ends; the anterior more slender and vibratile; length 1-950″; in marsh-water.

Three other species. Dujardin remarks that Ehrenberg's genus *Aspidisca* belongs here.

Bibl. Dujardin, *Infus.* 445; Claparède and Lachmann, *Infus.* 188.

COCKCHAFER. See Melolontha.

COCK-ROACH, or house black-beetle. See Blatta.

COCOA.—This substance consists of the seeds of *Theobroma Cacao* (Ternstrœmiaceæ), and is largely used in a manufactured form under this name; and, mixed with sugar and other ingredients, it forms chocolate. The various powders and pastes thus designated are often very extensively

falsified. A difference of quality is in the first place produced by the admixture or exclusion of the husk of the seeds; still more important degradation arises from the use of flours of various kinds, ground roots such as chicory added to give weight, together with coloured earths to disguise these.

The tissues forming the husk of the Cocoa-seed include outer loose filamentous cells, belonging rather to the seed-vessel; a membrane composed of a single layer of flat parenchymatous cells with thin walls (Pl. 2. fig. 4 *a*); and another, thicker, consisting of a number of layers of large parenchymatous cells containing mucilage and crystals (fig. 4 *b*), with spiral vessels and woody fibre; the outer part of the dark-coloured albumen of the seed is composed of angular, the internal mass of rounded cells of delicate structure filled with oil-globules and starch-granules (Pl. 2. fig. 4 *e*). In the interspace between the lobes occurs a finely fibrous tissue, in which are found crystals. The presence of the filamentous, the large parenchymatous cells, and the spiral vessels indicates when the bark has been ground up with the finer part of the seed.

The various flours and starches are to be detected by the characters of their granules (STARCH); the pitted ducts betray the presence of chicory or other roots (see CHICORY).

Chocolate is a compound made up with starches and sugar, and flavoured with cinnamon, vanilla, and other ingredients. The examination of its preparations must perhaps be limited to comparative richness in cocoa, and to the detection of coarse substitutes for arrowroot and similar starches.

BIBL. Hassall, *Food and its Adult.* 207.

COCOA-NUT.—The seed of the Cocoa-nut Palm, *Cocos nucifera* (Monocotyledon). Sections of the remarkably hard shell of this nut afford good specimens of very greatly consolidated woody tissue; while the fleshy contents form an example of oily albumen, the soft thick-walled cells containing abundance of drops of oil in their cavities. The husk of the nut is composed of fibres analogous in their structure to liber, and used for similar purposes. See FIBROUS STRUCTURES.

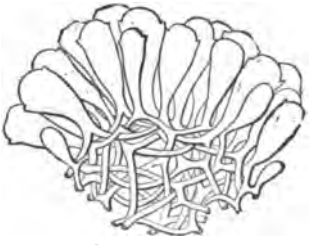
CODI'OLUM, Braun.—A genus of Unicellular Algæ, of which the only known species, *C. gregarium* (Pl. 5. fig. 6), is marine. It consists of a clavate tubular cell, attenuated from about midway into a slender base, by which it is attached to piles, &c. Length, when full-grown, about 1-25″, diameter of the clavate part about 1-300″; green above, clear below. The green contents are finally converted into many 2-ciliated zoospores, which escape by rupture of the cell, as in the sporanges of *Codium*.

C. gregarium was found at Heligoland, on submersed timber, and may be looked for on the British coast.

BIBL. Braun, *Alg. Unicell.* 1855, 19, pl. i.

CO'DIUM, Stackh.—A genus of Siphonaceæ (Confervoid Algæ); marine. The species have dark green spongy fronds of cylindrical, flat, globular or crust-like form, some inches in size, composed of interlacing continuous filaments devoid of septa, terminating in radiating club-shaped filaments at the surface (fig. 133). The sporanges

Fig. 133.



Codium tomentosum.
Saccate cells arising from the filaments at the surface. Magnified 10 diameters.

(spores) are produced in lateral branches from the clavate cells, forming long elliptical sacs, the contents of which are converted into a vast number of biciliated zoospores, discharged when mature (Pl. 6. fig. 15).

BIBL. Harvey, *Br. Mar. Alg.* pl. 24 A; *Phyc. Brit.* pl. 93. 35 B; and Thuret, *Ann. Sc. Nat.* 3 sér. xiv. 232, pl. 23. figs. 1–5.

CODONEL'LA, Haeckel.—A genus of Heterotrichous Infusoria (?); closely resembling minute *Medusæ* (*Jen. Zeitschr.* 1873; Kent, *Inf.* 615, figs.).

CODONŒ'CA, Clark.—A genus of Flagellate Infusoria.

Char. Solitary, 1-flagellate, sessile, in an erect stalked lorica.

2 species: marine and fresh water. (Kent, *Inf.* 261.)

CODOSI'GA, Clark.—A genus of Flagellate Infusoria.

Char. Ovate, attached to a simple or

branched pedicle, with a collar, and a single flagellum; reproduction by longitudinal division, and encysting, with division into germs.

C. botrytis=Epistylis b. Ehr. (Pl. 53. fig. 15). Fresh water. 9 other species. (Kent, *Infus.* 333.)

CŒLASTRUM, Näg.—A genus of Pediastreæ (?) (Confervoid Algæ).

Char. Cell-group or frond globose, hollow internally, formed of a single reticular layer of green cells.

C. Naegelii (Pl. 3. fig. 8). 3 other species: found in boggy pools.

Bibl. Nägeli, *Einzell. Alg.* 97; Rabenhorst, *Flor. Alg.* iii. 79.

CŒLENTERA'TA, Leuck.—A subkingdom of the Animal Kingdom, composed of the Zoophytes.

CŒLOCYS'TIS, Kütz.—Probably a resting form of Euglena, Henf.; = *Cœlosphærium*, Rab.

CŒLO'MONAS, Stein.—A genus of Flagellate Infusoria.

Char. Free, 1 flagellum, variable, mouth leading to a large chamber.

C. grandis=Monas g. Ehr. (Pl. 53. fig. 16): marsh-water. (Kent, *Infus.* 392.)

CŒLOSPHÆ'RIUM, Näg.—A genus of Palmellaceæ (Confervoid Algæ).

Char. Frond globose, minute, hollow within, consisting of minute æruginous cells immersed in a simple mucous envelope.

3 species. In ditches and pools.

Bibl. Rabenhorst, *Fl. Alg.* ii. 54; Archer, *Qu. Mic. Jn.* 1879, xix. 440.

CŒNOCO'LEUS, Berk. and Thwaites.—A genus of Oscillatoriaceæ, distinguished by the filaments growing "within a tough, skinny, more or less permanent outer coat." *C. Smithii* forms a red mat of interlacing threads on boggy soil; the separate filaments are green. *C. cirrhosum, Eng. Bot.* p. 2920, is a Desmonema.

Bibl. *English Bot.* Suppl. pl. 2940.

CŒNOGO'NIUM, Ehr.—A doubtful genus of tropical Lichens, usually placed among the Lecideinei. The thallus has a cuticular stratum variously and curiously marked.

14 species, growing on leaves, trees, and earth.

Bibl. Leighton, *Ceylon Lich.* 172.

CŒNU'RUS, Rudolphi.—A supposed genus of Entozoa, placed in the order Sterelmintha, and family Cystica; since proved to be nurse-forms or larvæ of *Tæniæ*.

Char. A simple vesicle filled with an albuminous liquid, upon the outer surface of which a number of soft, short, retractile, cylindrical and rugose rather than jointed bodies (scolices) are situated. The head of each resembles that of a *Tænia*, having four disks and a crown of hooks.

C. cerebralis (Pl. 21. fig. 10) is the larva of *Tænia cœnurus*, which infests the dog.

It occurs in the brain of sheep, producing the "staggers;" sometimes also in that of the Horse, the Ox, the Rabbit, &c. The vesicle is as large as the egg of a hen or a pigeon. The scolices when extended are about the 1-5 or 1-6″ in length. When retracted they appear to the naked eye as opaque white specks.

Other kinds occur in the lemur and the rabbit.

Bibl. Dujardin, *Helminthes*, 636; Küchenmeister, *Parasiten*; Cobbold, *Entozoa*, 1879.

COFFEE.—The "berries," as they are vulgarly called, of coffee, are the seeds of *Coffæa arabica*, a Dicotyledonous plant, of the Nat. Order Cinchonaceæ.

The "berries" consist of a mass of hard endosperm (horny Albumen), composed of closely adherent thick-walled angular cells (Pl. 2. fig. 5 *b*), with a thick skin composed of a layer of thin-walled parenchymatous cells forming a membrane, and a layer of hard, easily separable, pitted, thick-walled parenchymatous cells of larger size (Pl. 2. fig. 5 *a*); true spiral vessels occur in the groove on the inner face of the seed. Ground coffee is subject to very extensive adulterations, recognizable under the microscope; by which the vascular and parenchymatous tissues of roots, the starch or the integuments of various grains and seeds, &c. (mentioned more particularly under Chicory) may be discovered.

Bibl. Hassall, *Food &c.*

COIR.—The term coir-rope is applied to cordage manufactured from the fibrous tissue of the husk of the cocoa-nut. See Fibrous Structures.

COLA'CIUM, Ehr.—A genus of Flagellate Infusoria.

Char. Flagellum single, free like *Euglena* or attached by a simple or branched stalk, green, with red eye-spot.

C. vesiculosum (Pl. 30. fig. 32). Ovato-fusiform, variable, internal vesicles distinct, length 1-860″. Fresh water, on *Cyclops* &c.

C. stentorium. Cylindrical, conical, or funnel-shaped, variable, vesicles less dis-

tinct, pedicel generally branched, bright green; length 1-800″. Other species; mostly on Entomostraca (Ehr. *Inf.* 115; Kent, *Inf.* 393).

COLEOCHÆ'TE, De Brébiss.—A genus of Chætophoraceæ (Confervoid Algæ), of which one species, *C. scutata*, is apparently pretty common in freshwater pools, forming minute green disks (fig. 134) adhering to leaves, to the larger Confervæ, sticks, &c., also to the sides of glass vessels in which aquatic plants are kept growing. The disks are formed of a number of dichotomous filaments radiating from a central cell and cohering laterally, the whole being closely applied on the surface of support, so that the discoid form is occasionally modified by this (we have seen it forming a kind of cup and irregular fan-like lobes, on the ends of the articulations of *Hydrodictyon*). In certain cases the filaments are more or less free from their lateral union. From the back of many of the cells projects a long, tubular

Fig. 134. Fig. 136.

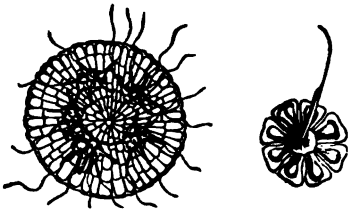


Fig. 135.

Coleochæte scutata.

Fig. 134. A perfect plant. Magnified 25 diameters.
Fig. 135. Cells with tubular processes from the back of the frond. Magnified 50 diameters.
Fig 136. Commencement of the development of a young frond. Magnified 100 diameters.

process (fig. 134), with a bulbous base. Reproduction by zoospores; and by fertilized resting-spores (oospores). The former are produced singly in the cells, from the whole contents; bear two cilia, and break out at the back of the cell in *C. scutata*, from the side in *C. pulvinata*. The resting-spores are formed in cells near the margin, in penultimate cells of the radiating filaments; on the back, therefore, in *C. scutata*, at the ends of the branches in *C. pulvinata*. These enlarge very much, and become surrounded by a kind of rind or cellular coat, through growth of cellular branchlets from the preceding and the surrounding cells, which branchlets meet and enclose them. The sporanges, with their trichogynes open at the end, receive the spermatozoids, and their contents are then converted into 5–8 resting-spores. The resting-spores do not directly form new plants, but numerous swarm-spores, and exhibiting alternations of generations: the first swarm-spores produce only asexual plants, with repeated broods of swarm-cells; finally comes a sexual generation, monœcious or dicecious according to the species; and then the spores or oogonia. The antheridia are flask-shaped cells, situated near the sporanges; the spermatozoids are biciliated, one in each cell.

C. scutata, De Bréb. (fig. 134); = *Phyllactidium*, Kütz. Fronds discoid, sporanges on the back. On aquatic plants, &c., common. A variety, β *soluta*, occurs with the radiating filaments more or less free.

C. pulvinata, Braun. Fronds composed of tufted-branched, radiating, free filaments; sporanges globose, at the ends of the filaments. *Chætophora tuberculata*, C. Müll., according to Kützing.

Rabenhorst describes 7 species.

Bibl. De Brébisson, *Ann. Sc. Nat.* 3 sér. i. 29, pl. 2; Ralfs, *Ann. N. H.* xvi. 309, pl. 10; Hass. *Alg.* 217, pl. 77; Braun, *Rejuv.* (*Ray Soc.* 1853); Kützing, *Sp. Alg.* 424; Müller, *Regensb.* '*Flora*,' xxv. B. ii. 513, pl. 3; Pringsheim, *Jahrb.* 1860, ii. 1; Rabenh. *Flor. Alg.* iii. 388; Sachs, *Bot.* 289.

COLEOP'TERA.—The 1st order of Insects, containing the beetles. See Insects.

COLEOSPO'RIUM, Leveillé.—A genus of Uredinei (Hypodermous Fungi), separated from *Uredo*, which proves to be a secondary form of many distinct and independent plants (see Uredo). These fungi, which may be well observed in *C. senecionis*, Schlecht., and other common species, appear as yellow, reddish, or brownish pulverulent spots upon the leaves of living plants. Their mycelium, creeping in the intercellular tissues of the plants upon which they are parasitic, consists of delicate branched filaments, which collect together at certain points, become interwoven, at the same time acquiring orange or yellow

cell-contents, so as to form a flat cushion-like body (*clinode* or *stroma*). From this arise vertical or radiating, branched, club-shaped, sac-like prolongations of some of the filaments: the oldest are found in the centre, the youngest at the circumference of the group. The club-shaped bodies, filled with yellow or brown contents, become firmly coherent laterally (at this stage they constitute *Uredo tremellosa*). This first spore is formed near the summit of the clavate sac, leaving a little clear space at the tip; then a second spore below the first, and so on to a third and a fourth, occasionally to a fifth; these increase in size so as to conceal the existence of the sacs on which they are seated; only the tips of all the laterally coherent sacs form by their union a transparent layer, presenting, when seen from above, somewhat the appearance of the cornea of the compound eye of an insect. This lamella is burst open, with the epidermis of the infected plant; and the spores (now *stylospores*), which grow into oval and globular forms, become detached from one another and lie loose, forming the yellow, red, or brown pulverulent spots above alluded to. The spores have a granular cuticle, and their coat is double. The above is the Uredo-form; besides this there is another form of fruit, in which the stalked rows of stylospores are represented by oblong 4–5-locular sacs, each of the chambers of which ultimately emits a long slender tube terminating in a minute reniform 'sporidium' (Tulasne). British species (we cannot find distinctive characters):

C. synantherarum, Fries. On Colt's-foot, &c., common. *U. compransor*, Schlecht. (in part); *U. tussilaginis*, Pers.

C. senecionis, Fr. On Groundsel, common. *U. senecionis*, Schlecht.

C. campanulacearum, Lev. On *Campanulæ*. *U. campanulæ*, Pers.

C. rhinanthacearum, Lev. On *Euphrasia*, &c. *U. rhinanthacearum*, De C.

C. pulsatillarum, Fr. *U. pulsatillarum*, Strauss.

C. pinguis, Lev. On leaves, &c. of roses, common. *U. effusa*, Strauss; Grev. *Sc. Crypt. Fl.* t. 19.

Bibl. Leveillé, *Ann. Sc. Nat.* 3 sér. viii. 369; De Bary, *Brandpilze*, Berlin, 1853, 24, pl. 2; Fries, *Summa Veget.* 512; Berk. in *Hook. Br. Fl.* ii. pt. 2. 377–9, &c.; Tulasne, *Ann. Sc. Nat.* 4 sér. ii. 135, 179; Cooke, *Micr. Fungi.*

COLEPI'NA, Ehr.—A family of Infusoria.

Char. Carapace barrel-shaped, traversed longitudinally or transversely, or both, by furrows, in which are situated minute vibratile cilia; truncate, and either smooth or dentate in front; posteriorly pointed or terminated by from two to five teeth; fresh and salt water.

Ehrenberg states that the oral and anal orifices exist at the opposite ends of the body. The gastric sacculi are readily filled with colouring-matter. Motion, that of revolution upon the longitudinal axis.

A single genus: *Coleps*.

CO'LEPS, Ehr.—A genus of Infusoria, of the family Colepina.

Char. Those of the family.

These animals are very voracious, and feed freely under the microscope upon the portions of the body of crushed Entomostraca, which attract them as much as sugar attracts flies.

C. hirtus (Pl. 30. fig. 33 *a*, Ehr.; fig. 33 *b*, Duj.) Oval, white, rounded behind, carapace tabulate, furrows transverse and longitudinal; posterior teeth three; length 1-570 to 1-430″.

β elongatus. Cylindrical, elongate, length as in the last.

C. viridis. Ovate, furrows transverse and longitudinal, green, posterior teeth three; length 1-960 to 1-570″.

C. amphacanthus. Ovate, carapace divided by transverse furrows only, anterior teeth unequal; posterior teeth three, large; length 1-280″.

C. incurvus. Oblong, nearly cylindrical, slightly curved, white, posterior teeth five; length 1-430″.

C. uncinatus, Berlin; fresh water.

C. fusus, Norway.

Bibl. Ehr. *Inf.* 317; Duj. *Inf.* 565; Clapar. & Lachm. *Inf.* 366; Kent, *Inf.* 506.

COLLA'RIUM, Link.—A genus of Sepedoniei (Hyphomycetous Fungi). Filaments crowded, septate, branched, with the spores agglomerated in little spots upon them.

C. nigrospermum, on dried paste; *C. fructigerum*, on decaying apples. The species should be referred to the Schizomycetes.

COLLE'MA, Ach.—A genus of gelatinous Lichens. Thallus without cortical layer, but consisting of a gelatinous mass of cells, with granular gonima in moniliform series, and with Lecanorine reddish apothecia; spores simple or septate. 40–50

species; of which 27 are found on earth, rocks, trees, &c. in Great Britain.

Bibl. Nylander, *Syn.* 101, pls. 2, 3, 4; Leighton, *Lich. Fl.* 1879, 15.

COLLEMACEI.—A family of Lichens, having a gelatinous thallus; comprising the tribes Lichenei and Collemei, which see.

COLLEMEI.—A tribe of gelatinous Lichens, fam. Collemacei, with a membranous lobate thallus.

Gen. *Pyrenopsis, Synalissa, Collema, Leptogium, Collemopsis*, and *Pyrenidium*.

COLLEMOP'SIS, Nyl.—A genus of Collemaceous Lichens, with the thallus glaucous-green internally. 7 British species.

Bibl. Leighton, *Lich. Fl.* 35.

COLLEN'CHYMA.—A peculiar kind of thickening of cellular tissue in the subepidermal layers of many herbaceous stems, such as *Rumex, Beta, Chenopodium*, &c.; which some have regarded as intercellular substance, while others, more correctly, have stated it to consist of metamorphosed secondary layers inside the cells. See Intercellular Substance.

COLLETONE'MA, Brébisson.—A genus of Diatomaceæ.

Char. Frustules navicular, sigmoid or straight, arranged in rows, and immersed in a gelatinous mucus, forming a filiform frond. Fresh water.

C. eximium. Valves sigmoid; length 1-340″.

C. vulgare. Valves elliptic-lanceolate, slightly contracted at ends; length 1-410″.

C. neglectum. Valves elliptic-lanceolate; length 1-250″.

C. subcohærens = *Micromega subcohærens.*

Three other species, *C. viridulum, C. lacustre*, and *C. flexile.*

Rabenhorst arranges these in a section of the genus *Schizonema.*

Bibl. Smith, *Brit. Diat.* ii. 69; Kützing, *Sp. Alg.* 105; Rabenhorst. *Fl. Alg.* i. 265.

COLLOID MATTER, exudation and corpuscles (animal).

The term colloid matter or exudation is applied to a transparent, viscid, yellowish, structureless or slightly granular matter, resembling liquid gelatine, arising from the metamorphosis of the protoplasm of the cells. It occurs as a normal and a pathological product. In a state of greater consistence, it sometimes forms flakes or irregular masses, which occasionally possess a laminated structure. In a third form it constitutes spherical, rounded or oval, sometimes flattened microscopic corpuscles —simple masses of sarcode (Pl. 38. fig. 22 *a*). These are either homogeneous, or exhibit numerous laminæ (concentric colloid corpuscles) (Pl. 38. fig. 22 *b*): sometimes a kind of nuclear body is present (fig. 22 *c*); at others they contain carbonate and phosphate of lime (fig. 22 *d*). Sometimes they exhibit a radiate appearance (fig. 22 *e*). In the liquid form, colloid exudation is found within cysts in the thymus and thyroid glands, the ovary, &c., and within the enlarged areolæ of areolar tissue around these organs, &c. It is found in a free state upon the surface of inflamed serous membranes.

The colloid corpuscles are met with in the hypertrophied heart, in the prostate, the thyroid, and the thymus glands, in the choroid membrane, in the brain and spinal cord, and in the (waxy) spleen, &c.

The liquid colloid matter is not precipitated by acetic acid; it becomes of a gelatinous consistence, retaining its transparency or turbid and opaque, by heat. The colloid corpuscles do not, however, appear to be uniform in composition: sometimes they consist of a proteine-compound; at others, doubtfully, of cellulose or amyloid, as in the brain (true Corpora amylacea). These bodies are further noticed under the heads of the tissues and organs in which they occur. See also Tumours (*Colloid cancer*).

Bibl. Rokitansky, *Path. Anat.* i. 304; Wedl, *Path. Histol.*; Förster, *Hand. spec. Path.*; Virchow, *Arch. Path. Anat.* v.; Rindfleisch, *Path. Gewebelehre*, 29; Green, *Pathol. &c.* 57.

COLLO'MIA, Nutt.—A genus of Polemoniaceæ (Dicotyledons) remarkable for the spiral structures produced in the epidermis of the seeds (Pl. 28. fig. 22) (see Spiral Structures). The gummy substance in which fibre is imbedded is soluble in water and not in spirit; therefore the best way to observe the elastic opening of the spiral fibres is to make fine sections of the coat of the seed and place them in a little spirit of wine, upon a slide, with a covering glass, to adjust the focus, and then to add water carefully at the side of the covering glass so as to wash away or dilute the spirit.

COLLOSPHÆRA, Müll.—A genus of Radiolaria, fam. Thalassicollidæ.

Char. Skeleton consisting of simple spherical roundish or polyhedral fenestrated shells, smooth or spinous, each of which surrounds one of the combined central capsules.

C. Huxleyi (*Thalassicolla punctata*, pt.). Shell smooth; diam. $\frac{1}{25}$". In various seas.

C. spinosa. Shell spinous. Lessina.

BIBL. Haeckel, *Radiolar.* 533; Huxley, *Ann. N. H.* 1851, viii. 434, pl. 16. fig. 6.

COLORADO BEETLE. See DORYPHORA.

COLOSTRUM.—The first liquid secreted by the mammary glands. See MILK.

COLOUR. See INTRODUCTION, p. xxxiv.

COLOURING MATTER, OF ANIMALS. See PIGMENT.

COLOURING MATTERS, of PLANTS. —The green colour of vegetables depends upon the presence of CHLOROPHYLL, and is spoken of under that head. The red and yellow colours assumed by leaves and herbaceous shoots in autumn depend upon a chemical metamorphosis of the chlorophyll, or on its absorption and the discoloration of the cellular tissue. The colours of red cabbage, copper beech and similar plants, depend upon the existence of a colouring liquid in the usually colourless epidermal cells, obscuring the chlorophyll which lies beneath. The red colour presented by many of the lower Algæ, such as some of the Palmellaceæ, appears also to depend upon a metamorphosis of the chlorophyll, connected with the vital processes; it is met with also in the contents of the resting-spores of many of the filamentous Confervoids. The protoplasm assumes a reddish colour in the *punctum vegetationis* of the buds of Monocotyledons in the autumn, which probably depends upon a similar cause. The bright colours of flowers and other parts of the inflorescence of plants, as also of the lower surface of many leaves (*Begoniæ*, *Victoriæ*, &c.) and herbaceous shoots, arise from the presence of matters of a different kind, almost always dissolved in the watery cell-sap. The colour of petals is ordinarily found to depend upon a certain number of the cells subjacent to the epidermal layer being filled with a coloured fluid; and the depth of the colour is proportionate to the number of superimposed layers of such cells, which act like so many layers of a pigment. Each cell is usually filled with one colour when fully developed; but adjacent cells are often seen, in variegated petals, to contain distinct colours, the line of demarcation being accurately fixed by the cell-walls, through which the colours do not transude, unless the cells are injured by pressure. In young tissues the colour often has a granular appearance in the cells; but this is a deception arising from the mode in which the colour is developed. The colourless protoplasm originally filling the cells becomes excavated, as it were, by water-bubbles, and the watery contents of the excavations become coloured; they gradually enlarge as the protoplasm applies itself more completely to the walls of the cell, until they become confluent and the coloured liquid fills the whole cell-cavity. The isolation of the coloured juice in each particular cell seems to depend upon the primordial utricle or parietal layer of protoplasm; when this is injured by pressure, or other external cause, endosmose is soon set up and the integrity of the cell destroyed.

In some cases the liquid colouring-matters of flowers have been found to contain solid corpuscles: the red colour-cells of *Salvia splendens*, and the blue ones of *Strelitzia regina*, contain globules; and according to Mohl, this is still more commonly the case with the yellow colours: in the yellow perigonial leaves of *Strelitzia regina* the yellow colour is said to depend upon the presence of crescentic and curled filaments floating in the cell-sap.

The white patches upon variegated and spotted leaves, such as those of *Aucuba*, Holly, variegated Mint, *Begonia argyrostigma*, &c., arise from the absence of chlorophyll in the cells subjacent to the epidermis at those parts, which produces the same effects as we see in leaves mined by caterpillars.

BIBL. Von Mohl, *Verm. Schrift.* 575.

COLPIDIUM, Stein, = *Paramecium kolpoda*, Ehr. & Cl. & Lachmann (Kent, *Infus.* 537).

COLPOCEPHALUM.—A subgenus of *Liotheum* (ANOPLURA).

C. longicaudum, and four other species; found on pigeons.

BIBL. Mégnin, *Parasites*, 91 (fig.).

COLPODA, Schrank, Ehr.—A genus of Holotrichous Infusoria, of the family Colpodea, Ehr., Colpodina, Cl. & L.

Char. No eye-spot; body sinuous or notched on one side, sometimes reniform, surface reticulated or marked with nodular obliquely interlacing striæ; mouth lateral,

situated at the bottom of the notch, and furnished with a projecting lip.

C. cucullus (Pl. 31. fig. 25). Turgid, slightly compressed, reniform, often narrowed in front; length 1-1720 to 1-280″. Common is vegetable infusions, especially of hay. Ecdysis has been observed in this animalcule.

Stein describes the encysting process and reproduction from germs as occurring in this infusorium.

C.? ren. Ovato-cylindrical, reniform, rounded at the ends; fresh wat.; length 1-280″.

C.? cucullio (*Loxodes cuc.*, Duj.). Compressed, flat, elliptical, slightly sinuous in front; fresh wat.; length 1-900″.

C. parvifrons, Cl. & L. No anterior recurvature, contractile vesicle not terminal. Fresh water.

Bibl. Ehr. *Inf.* 347; Duj. *Inf.* 478; Stein, *Infusionsth*; Claparède & Lachmann, 270; Kent, *Infus.* 512.

COLPODEL'LA, Cienk.—A genus of Flagellate Infusoria.

Char. Free or adherent, ovate or elongate, one flagellum, with a suctorial cavity at the base; becomes encysted.

C. pugnax (Pl. 53. fig. 14). Fresh water; preying on *Chlamydomonas*; length 1-2000″. (Kent, *Inf.* 378.)

COLPODI'NA, Cl. & L.—A family of Infusoria, characterized by the presence of cilia all over the body, the patent and ciliated œsophagus, and the absence of rows of buccal cilia directing the particles of food to the mouth.

Genera:

Membranous lips absent.
- No setæ projecting from the mouth ..... 1. *Paramecium.*

Setæ projecting from the mouth.
- A bundle of short setæ forming a lower lip..... 2. *Colpoda.*

Oral setæ long, isolated.
- No ventral setæ ..... 3. *Cyclidium.*
- A bundle of ventral setæ... 4. *Pleuronema.*

Lips membranous, oscillatory..... 5. *Glaucoma.*

COLPONE'MA, Stein.—A genus of Flagellate Infusoria.

Char. Free, ovate, pointed and curved, with a ventral groove; flagella two, one apical and vibratile, the other ventral and trailing.

C. loxodes. Fresh water (Kent, *Inf.* 297).

COLUREL'LA, Bory, Duj. = *Colurus*, Ehr.

COLU'RUS, Ehr.—A genus of Rotatoria, of the family Enchlanidota.

Char. Two frontal eye-spots; tail-like foot forked; carapace cylindrical or compressed.

Carapace open beneath; cervical appendage curved; jaws with two or three teeth each.

C. deflexus (Pl. 43. fig. 12, dorsal view; 13, ventral view; 14, teeth). Carapace ovate, compressed, its posterior points long and directed downwards; terminal points of foot (toes, E.) shorter than the foot itself; length of carapace 1-240″. Freshwater.

C. caudatus. Carapace ovate, compressed, posterior points of carapace distinct, points of foot longer than the foot itself; freshwater and marine; length 1-240″.

C.? uncinatus and *bicuspidatus* are doubtful species.

Bibl. Ehr. *Infus.* 475.

COMBEA, D.N.—A genus of podetiiform Lichens, tribe Roccellei. 1 species, *C. mollusca*; rocks, Cape of Good Hope.

Bibl. Ach. *Meth.* 235, pl. 4. f. 5; Nyl. *Syn.* 257, pl. 8. f. 1.

COMPRESSOR. Introduction, p. xxiii.; Ross's new compressor is described in *Qu. Micr. Jn.* 1864, 44,

COMP'SOGON, Mont.—A genus of Lemaneeæ (Confervoid Algæ).

1 European species: *C. Corinaldii.* Capillary, much branched, violet. Freshwater.

CONCEPTACLE.—A form of fructification in the Florideæ and Fucoideæ. Also occurring in the fructification of some Fungi.

CONCHŒ'CIA, Dana.—A genus of Ostracode Entomostraca, fam. Conchœciadæ.

Char. Those of the family.

C. obtusata, Sars. Shetland.

Bibl. Dana, *Crustac. Explor. Expedit.* &c.; Sars, *Oversigt af Norges mar. Ostr.* 118; Brady, *Linn. Tr.* xxvi. 469.

CONCHŒ'CIADÆ.—A family of Entomostraca, of the order Ostracoda.

Char. Inferior antennæ 2-branched, one branch rudimentary and immoveable; feet 2 pairs, posterior rudimentary, eyes none. 1 genus, *Conchœcia.*

CONCHOPHTHI'RUS, Stein.—A genus of Holotrichous Infusoria.

Char. Free, oblong, dorsally convex, striate.

C. anodontæ = *Leucophrys an.* Ehr. In the "body-mucilage" of freshwater Mollusca. 2 other species. (Kent, *Inf.* 490.)

CONCRETIONS and CALCULI.—These terms are rather indefinite. A hard body of comparatively considerable size, formed within an animal organism, would be called a calculus, whilst a body of considerable comparative size in which hardness was not a marked feature, or a hard body of small or microscopic dimensions, would be called a concretion. Under the latter term, the notion of a compound structure is usually implied. Calculi generally consist of various organic and inorganic substances entering into the composition of the secretions of the body, which are precipitated from various causes. Those found in the intestinal canal are mostly composed of undigested vegetable tissues derived from the food. Most, if not all, calculi and concretions are mixed with animal matter (proteine-compounds) derived from the mucous cavities in which they are contained,—or simultaneously precipitated, with their characteristic compounds, from the secretions in the midst of which they are formed. Hence when the proper calculous matter is dissolved by a reagent which exerts little or no action upon the animal matter, a mass is left which exhibits the form of the original body; and the organic cast often so resembles a cell, that some hasty observers have attributed to calculi a cell-origin.

Calculi and concretions enlarge by the deposition of new matter upon their outer surface; and as this deposition is not uniform and uninterrupted, either in regard to the nature or proportion of the respective constituents, they mostly exhibit a laminated structure. This is visible to the naked eye in the larger ones, and evidenced in those which are microscopic by the appearance of concentric rings, and of a nucleus or nuclei. These concentric rings and nuclei are distinguishable equally in concretions formed artificially as in those occurring naturally.

The inorganic matter in concretions is in the crystalline state, the crystals being usually small, granular or radiate, and intermingled with the organic substance; which arrangement is conveniently expressed by Ehrenberg's term "crystalloid." The crystalloids have a great resemblance to cells, for which they have often been mistaken.

Bibl. Taylor, *Hunt. Catalogue*, Calculi; Quekett, *Med. Times*, 1851, xxiv. 551; Griffith, *Med. Times and Gaz.* 1852, xxv. 272; Rainey, *Medico-Chir. Rev.* 1857, and *Qu. Mic. Jn.* 1858; Meckel, *Mikrogeologie.*

CONDENSER, Achromatic, BULL'S-EYE, &c., for opaque objects. Introduction, pp. xix & xx.

CONFER'VA, Plin.—A genus of Confervaceæ (Confervoid Algæ), which, as restricted here, contains chiefly marine species; but we have thought it advisable to retain in it the species separated by Kützing as *Chætomorpha* and by Thuret as *Microspora*; so that our *Conferva* corresponds to Hassall's proposed genus *Aplonema*. The plants consist of unbranched filaments, composed of cylindrical or moniliform cells, the length and diameter of which have a very variable relation in different species, and containing starch-granules. The species with moniliform cells form Kützing's *Glœotila*. They are reproduced by zoospores formed from the cell-contents. Braun says that *C. bombycina* produces four in a cell. According to Thuret, *C. ærea* produces large numbers, which escape by a lateral orifice; while the species he describes as *Microspora floccosa* forms a number which escape by a circular dehiscence breaking up the filaments. The zoospores are 2-ciliated in general, but sometimes bear four. The spores have not been observed; and hence Kützing has suggested that the *Confervæ* may be sterile forms of *Œdogonium*; but the true *Œdogonia* produce solitary zoospores with a crown of cilia. Rabenhorst describes 30 species. British species:—

Freshwater.

C. bombycina, Ag. Filaments 1-360 to 1-180″ in diameter, four or five times as long, forming a yellow-green cloudy stratum. Common in stagnant water. Dillw. *Confervæ*, pl. 60.

C. floccosa, Ag. (Pl. 9. fig. 11 *b*). More robust; articulations once or twice as long as broad. *Microspora floccosa*, Thuret, *Ann. des Sc. Nat.* 3 sér. xiv. pl. 17. figs. 6,7.

Marine.

Thirteen species are described by Harvey (*Mar. Algæ*), of which *C. ærea*, Dillw., is one of the commonest, remarkable for the large size of the tufted filaments, as thick as hog's bristles, growing 3 to 12″ long, of a yellow-green colour. *C. Melagonium*, Web. and Mohr, has erect tufted filaments equally thick; while *C. Linum*, Roth, has

entangled filaments twice as thick, deep glossy green, and many feet long.

The cell-walls of these large marine species present a curious striated appearance when treated with acids, which led J. Agardh, apparently erroneously, to suppose they are composed of spiral filaments. (See SPIRAL STRUCTURES.)

BIBL. Harvey, *Phyc. Brit.*; Thuret, *loc. cit.*; Kützing, *Sp. Alg.*; Hassall, *Freshw. Alg.* 213; Braun, *Rejuv.* (*Ray Soc.* 1853, 184); Rabenhorst, *Fl. Alg.* iii. 322.

CONFERVA'CEÆ.—A family of Confervoideæ. Marine or freshwater Algæ; composed of articulated filaments, simple or branched; cells cylindrical, shortish, not conjugating. The fourth and fifth genera given below are placed here doubtfully; *Stigeoclonium*, if a good genus, leads to *Draparnaldia* among the Chætophoraceæ. Reproduction by zoospores; spores unknown.

Synopsis of the British Genera.

Conferva. Filaments unbranched. Zoospores minute, numerous in the cells. Sea, brackish, and fresh water.

Glœotila, Microspora, Chætomorpha, Cladophora. Filaments tufted, much branched. Sea and fresh water. Zoospores minute, many in a cell.

Rhizoclonium. Filaments decumbent, with small lateral rootlike branches. Zoospores minute, numerous. Sea, brackish, and fresh water.

Ulothrix. Filaments simple, often fasciculated, joints short. Zoospores 4-ciliated; two, four, or more in a cell. Fresh water.

Stigeoclonium. Filaments branched, forming tufts, the ramules running out into slender points; cell-walls often dissolving to emit the zoospores. Zoospores 4-ciliated, one in a cell.

CONFERVOI'DEÆ or CHLOROSPO'REÆ.—An order of Algæ. The Chlorospores or Confervoids, the lowest order of the Algæ, display a preponderating number of truly microscopical plants, and constitute one of the favourite and most instructive fields of microscopic research. As yet, however, the minute history of development is wanting in a very large number, while the facts already disclosed are so varied that it becomes a matter of difficulty to draw up a sketch of their characteristics in a brief space.

Among the Palmellaceæ we find some of the simplest forms of vegetable life, where the organization is reduced to the condition of a single microscopic membranous vesicle enclosing nitrogenous contents, ordinarily tinged with chlorophyll, and containing starch. Such we have in *Protococcus*, which in its various forms appears as a green or red stain on damp surfaces, or a green or red scum in water. These plants multiply by the subdivision of the cells into two or four new ones, which separate and repeat the process. In addition to the vegetative growth by subdivision, going on in damp air (the cells being held together more or less firmly in a gelatinous crust), the contents of the individual cells are set free by solution of the membranes when placed in water, and emerge as ciliated zoospores, endowed with active motion. Advancing a step, we come to a number of genera not yet well defined, in which the membranes of the parent cells soften into a kind of gelatine, during the process of subdivision, and hold the new cells together in groups of definite or indefinite form; among these are *Palmella*, *Glœocapsa*, and others of like nature, in which at present no zoospores have been discovered. In *Coccochloris* a process of conjugation occurs. These genera exhibit a *resting* form, characterized by the increased thickness of the membrane of the cell, and a change of the green contents into a brownish, reddish, or even crimson colour. With the Palmellaceæ we shall associate a number of Unicellular Algæ, whose characters and affinities are still obscure.

The Ulvaceæ are not widely separated from the Palmellaceæ; but the conjunction of the cells into a definite membrane, indicates a higher organization. In other respects, however, they hardly differ more from some of the more perfect genera of Palmellaceæ, than those do from *Protococcus*; and therefore, although more conspicuous and extensively developed than the Nostochaceæ and Desmidiaceæ, it seems natural to place the Ulvaceæ near the Palmellaceæ, especially as the reproduction by cell-division and by zoospores is analogous in all respects to what is seen in *Protococcus*, of which they would appear to be the *permanently aquatic* representatives. *Prasiola* and *Schizogonium*, however, differ from the other Ulvaceæ in the absence of zoospores, the homogeneous not granular contents of the cells being discharged as motionless spore-like bodies, from which new fronds grow up.

The Nostochaceæ exhibit but a slight advance in organization over the Palmel-

lacæ. They are composed of linear series of cells, mostly inflated so as to give the filaments a beaded appearance; the linear series increase in length by transverse division, and in some stages subdivide longitudinally; larger globular cells (sporanges) occur at intervals in the lines, with others devoid of endochrome (vesicular cells, Thwaites). During the increase, the older external membranes soften into a gelatinous coat. In *Nostoc*, where the filaments accumulate in large numbers, they lie elegantly curled and entwined in masses of this jelly, which exhibit a more or less definite, lobed, external form; appearing to the naked eye as gelatinous crusts or globular masses, as they lie upon damp ground or among mosses. Each sporange produces one resting-spore, which breaks out from it in germination.

Nearly allied to *Protococcus* stands a family which until recently have often been regarded as animals, namely the Volvocineæ; which consist essentially of groups of organisms identical with the ciliated zoospores, held together in a definite form by a common membranous envelope or cœnobium, through which the cilia penetrate, so that the entire full-grown plant moves freely in the water, as in *Volvox*, *Gonium*, *Pandorina*, &c. These plants multiply by division, the swarm-cells conjugating; also by resting-spores, which are formed after a true fecundation by spermatozoids.

The Desmidiaceæ form another tribe of very simple organization, where the individual plant is composed of a single cell; but here the coat or enclosing membrane is peculiarly characterized by the assumption of remarkable forms unlike any other vegetable structures; presenting angular and escalloped outlines or elegant processes projecting from the wall, but always so as to exhibit a bilateral symmetry. These cells are isolated or arranged in linear series or beautiful complicated star-like groups, enclosed at first in a common gelatinous envelope, but readily breaking up into isolated frustules. They are further remarkable for exhibiting the process of *conjugation* with great distinctness; resulting in the production of peculiarly formed bodies, zygospores, with rigid external membranes, which are generally regarded, probably correctly, as sporanges. They are also reproduced by zoospores.

The Diatomaceæ are nearly related in many respects to the Desmidiaceæ; but, on the other hand, diverge from the ordinary characters of plants so much in other respects, that some authors have placed them in the animal kingdom. Like the Desmidiaceæ, they are microscopic simple cells, isolated or coherent in groups; and either free, or imbedded in a definitely or indefinitely formed mucous nidus. They differ however from the Desmidiaceæ, in possessing, when free, a more active power of locomotion, and also by being often attached by a kind of foot, and this either singly or in large polypiform families. Their great distinctive character is the presence of a siliceous coat to the cell, which preserves the form of the organism when the soft parts are removed by fire or acids. The cell-contents of the Diatomaceæ are usually of a dirty yellow colour, the colour of the chlorphyll being concealed by a yellow matter—diatomine (phycoxanthine). The reproduction is by division, and by conjugation, analogous to that of the Desmidiaceæ.

The Oscillatoriaceæ are truly filamentous plants, the component parts of which, though readily separating under external influences, are often combined into complex fronds in their normal state. The filaments of this group are mostly very minute, and exhibit transverse markings, which in some cases are so delicate that they cannot be regarded as actual divisions of cell-contents by septa; yet the filaments break readily across in these places, and the fragments go on growing. In the larger forms the articulations of the cell-contents are more distinct; but even here the filaments look like rows of individual masses of cell-contents contained in a common tube, forming a kind of sheath. In some genera the filaments are contained in bundles in secondary sheaths. The most remarkable point about this tribe is the occurrence of the peculiar kind of motion in the typical genus *Oscillatoria*, whence it derives its name: the filaments emerge readily from their sheaths and wave backwards and forwards, and the broken fragments oscillate like the beam of a balance; from what cause, or by what means, is still undecided.

The only known mode of reproduction is by the breaking up of the filaments into longer or shorter pieces, or into single joints. Peculiar large cells occur at the base of the filaments of some of the adnate genera; but their nature is unexplained.

The Siphonaceæ are plants of larger

dimensions and higher organization than any of the preceding; and indeed they are placed among the lower Fucoids by some authors. They seem to us to be more in place here. They are composed of tubular cells of much larger size than those of any other Confervoids, the entire plant often consisting of one undivided tube, while in other cases the branches arise from true articulations. In *Botrydium* a very curious structure is exhibited: the plant consists of a tough membranous globule, filled with green matter, rising from a branched, colourless, root-like portion spreading in the damp ground, the whole consisting only of one very large undivided cell. In *Vaucheria* and *Bryopsis* the tubular cell grows into a long filament, more or less branched, but not divided. In *Hydrodictyon*, which from its general structure appears referable here, the plant is a large net with meshes half an inch broad, the net itself being composed of large tubes rounded at both ends, articulated at the intersections of the meshes. In *Codium*, the filaments are closely combined into a spongy mass. The fructification of these genera is very varied, so that the group appears scarcely natural; but the plants are all more or less anomalous, and have affinities with very different tribes, while the comparatively enormous cells of which they are composed are peculiar to them among the filamentous Confervoids. *Vaucheria* is reproduced by very large oval gonidia covered with innumerable vibratile cilia, by means of which they swim actively in water; the gonidia are developed from the contents of the ends of the filaments; and zoospores, produced under various circumstances, seem to occur in all the other genera. In *Vaucheria* sexual reproduction is also known; sporangial and antheridial branches being formed at the sides of the main filaments. The *Saprolegnieæ* (*Achlya*, &c.), were formerly included in this family, on account of their general structure; but they are distinguished by the absence of chlorophyll in their cell-contents, and their parasitic habit, which gives them the character of aquatic Fungi.

The Œdogoniaceæ are green, simple or branched, filamentous plants, attached to foreign bodies under water—their cells, filled with green matter, presenting a peculiar mode of division; and the entire contents of the cells are converted into zoospores which have a crown of numerous cilia. In the sexual reproduction, the spores are formed from the entire contents of certain cells, which are impregnated by spermatozoids produced on other parts of the plant, or by antheridial plants developed from some of the gonidia.

The Zygnemaceæ are somewhat similar filamentous plants, remarkable for the process of CONJUGATION or inosculation of neighbouring cells of distinct filaments in order to the production of the resting-spores. They are also distinguished by the endochrome being arranged in spiral bands or other patterns on the cell-walls. It is doubtful whether zoospores occur here normally.

The Confervaceæ are simple or branched filamentous forms, of which the essential characters are imperfectly known. They produce numerous zoospores with two or four cilia, in each cell.

The Chætophoraceæ differ from the Confervaceæ principally in their habit and mode of branching. They occur in fresh water and in the sea; and are characterized by the presence of a jelly enveloping the filaments, which form branched, round, or shapeless masses, or flat discoid or irregular plates, and by the cells constituting the joints of the filaments bearing slender bristle-like branches. They are reproduced by zoospores, either numerous or solitary in the cells, bearing *four* cilia; also by spores formed after fecundation.

The Batrachospermeæ exhibit a greater complexity of structure, consisting of jointed moniliform filaments, composed of rows of cells, branched and bearing whorls of ramuli; the filaments of the whorls dense, dichotomous, and beaded, some of them growing down over the central filament, and forming a sheath round it. The fructification consists of spore-like bodies, or cystocarps with trichogynes, borne on the filaments of the whorls, and of bodies resembling the antheridia of the Florideæ. The plants are brownish green or purplish, and occur in fresh water.

The Lemaneeæ are freshwater Algæ, occurring in rapid rivers, attached to stones, by some supposed to bear a close relation to the lower Fucoids. The fronds are branched and of leathery texture, consisting of tubes composed of cellular tissue,—the superficial layers small, polygonal, and firmly conjoined—the deeper layers, bounding the cavity of the tubes, lax and spherical. The fructification consists of beaded filaments arising from the internal cells, and grow-

ing out freely in the cavity of the tube, finally breaking up into the component bead-like cells (*spores*), which reproduce the plant. The genus *Lemanea* deserves further investigation.

Synopsis of the Families.

LEMANEÆ. *Frond* filamentous, inarticulate, cartilaginous-leathery, hollow, furnished at irregular distances with whorls of warts, or necklace-shaped. *Fructification*: tufted, simple or branched, necklace-shaped filaments, attached to the inner surface of the tubular frond, and finally breaking up into elliptical *spores*. *Freshwater*.

BATRACHOSPERMEÆ. *Plants* filamentous, articulated, invested with gelatine. *Frond* composed of aggregated, articulate, longitudinal cells; whorled at intervals with short, horizontal, cylindrical or beaded, jointed ramuli. *Fructification*: ovate *spores*, and tufts of *antheridial cells* attached to the lateral ramuli, which consist of minute, radiating, dichotomous, beaded filaments. *Freshwater plants*.

CHÆTOPHORACEÆ. Plants growing in the sea or fresh water, coated by gelatinous substance: either filiform, or (a number of filaments being connected together) constituting gelatinous, definitely formed or shapeless fronds or masses. *Filaments* jointed, bearing bristle-like processes. *Fructification*: *zoospores* produced from the cell-contents of the filaments; *resting-spores* formed from the contents of particular cells after impregnation by ciliated spermatozoids produced in distinct *antheridial cells* (*Coleochæte*).

CONFERVACEÆ. Plants growing in fresh water, or in the sea, filamentous, jointed, without evident gelatine (forming merely a delicate coat around the separate filaments). *Filaments* very variable in appearance, simple or branched; the cells constituting the articulation of the filaments more or less filled with green or very rarely brown or purple granular matter, sometimes arranged in peculiar patterns on the walls, and convertible into *spores* or *zoospores*. Not conjugating.

ZYGNEMACEÆ. Freshwater filamentous plants, without evident gelatine, composed of series of cylindrical cells, straight or curved. Cell-contents often arranged in elegant patterns on the walls. *Reproduction* resulting from *conjugation*, followed by the development of a true *spore*, in some genera dividing into four *sporules* before germination.

(EDOGONIACEÆ. Simple or branched, freshwater, filamentous plants, attached without gelatine. Cell-contents uniform, dense. Cell-division accompanied by circumscissile dehiscence of the parent cell, producing rings upon the filaments. *Reproduction* by *zoospores* formed of the whole contents of a cell, with a crown of numerous cilia; and *resting-spores* formed in sporangial cells after fecundation by ciliated spermatozoids formed in *antheridial cells*.

SIPHONACEÆ. Plants found in the sea, fresh water, or on damp ground; of a membranous or horny hyaline substance, filled with green granular matter. *Fronds* consisting of continuous tubular filaments, either free or collected into spongy masses of various shapes, either crustaceous, globular, cylindrical or flat. *Fructification* by *zoospores* either single or very numerous; and by *resting-spores* formed in sporangial cells after the contents have been impregnated by the contents of *antheridial cells* of different form.

OSCILLATORIACEÆ. Plants growing either in the sea, in fresh water, or on damp ground, of a gelatinous substance and filamentous structure. *Filaments* very slender, tubular, continuous, filled with coloured granular, transversely striate substance; seldom branched, though often cohering together so as to appear branched, usually massed together in broad floating or sessile strata, of very gelatinous nature; occasionally erect and tufted, and still more rarely collected into radiating series bound together by firm gelatine, and then forming globose, lobed, or flat crustaceous fronds. *Fructification*: the internal mass or the cell-contents, separating into roundish or lenticular gonidia.

NOSTOCHACEÆ. Gelatinous plants growing in fresh water or in damp situations among mosses, &c.; of soft or almost leathery substance, consisting of variously curled or twisted necklace-shaped filaments, colourless or green, composed of simple (or in some stages double) rows of cells, contained in a gelatinous matrix of definite form, or heaped together without order in a gelatinous mass. Some of the cells enlarged, and then forming either *vesicular* empty cells or densely filled *sporangial* cells. *Reproduction* by the breaking up of the filaments, and by *resting-spores* formed singly in the sporanges.

ULVACEÆ. Marine or freshwater Algæ, consisting of membranous flat and expanded tubular or saccate fronds composed of polygonal cells firmly conjoined by their sides. *Reproduced* by *zoospores* formed from the cell-contents and breaking out from the surface; or by motionless *spores* formed from the whole contents of a cell.

PALMELLACEÆ. Plants forming gelatinous or pulverulent crusts on damp surfaces of stone, wood, &c., or more or less regular masses of gelatinous substance, or delicate pseudo-membranous expansions or fronds, of flat, globular, or tubular form, in fresh water or on damp ground; composed of one or many, sometimes innumerable, cells with green, red, or yellowish contents, spherical or elliptical form,—the simplest being isolated cells (found in groups of two, four, eight, &c. in course of multiplication); others permanently formed of some multiple of four; the highest of compact, numerous, more or less closely conjoined cells. *Reproduction* by *cell-division*; by the conversion of the cell-contents into *zoospores*; and by *resting-spores*, formed sometimes after conjugation, in other cases probably after fecundation by spermatozoids.

We shall include under the head of Palmellaceæ, all those obscure Unicellular Algæ whose place is not at present satisfactorily known.

DESMIDIACEÆ. Microscopic, gelatinous plants, of a green colour, growing in fresh water; composed of cells devoid of a siliceous coat, of peculiar forms, such as oval, crescentic, shortly cylindrical, or cylindric-oblong, &c., with variously-formed rays or lobes, giving a more or less stellate form, presenting a bilateral symmetry, the junction of the halves being marked by a division of the green contents: the individual cells either free, or arranged in linear series, collected into faggot-like bundles, or in elegant star-like groups, which are imbedded in a common gelatinous coat. Reproduced by *division*, and by *resting-spores* produced in *sporangia* formed after the conjugation of two cells and union of their contents; and by *zoospores* formed in the vegetative cells (*Pediastrum*), or in the germinating resting-spores.

DIATOMACEÆ. Microscopic cellular bodies, growing in fresh, brackish, and sea-water; free or attached; single or imbedded in gelatinous tubes; the individual cells (*frustules*) with yellowish or brownish, rarely greenish, contents, and provided with a siliceous coat composed of two usually symmetrical valves variously marked; with a connecting band or *hoop* at the suture. Multiplied by longitudinal *division*; and by the formation of *new larger individuals* out of the contents of *conjugated cells*; perhaps also by *spores* and *zoospores*.

VOLVOCINEÆ. Microscopic, cellular, freshwater plants, composed of groups of bodies resembling zoospores, connected into a definite form by their enveloping membranes. The plants (families) are formed either of assemblages of coated zoospores united in a definite form by the cohesion of their membranes, or of assemblages of naked zoospores enclosed in a large common investing membrane. The individual zoospore-like bodies with two cilia throughout life, perforating the membranous coats, and by their conjoined action causing a free movement of the entire group. *Reproduction* by division (*Gonium*); or by single cells becoming converted into zoospores which conjugate and form new families (*Pandorina, Volvox*); and by *resting-spores* formed from some of the cells after impregnation by spermatozoids formed from the contents of other cells of the same family.

BIBL. See the Families.

CONIDIA.—The name applied by Fries to the stalked spores, stylogonidia, or reproductive cells, produced directly from the mycelium of many Fungi (Pl. 26. fig. 8): characteristic of the Coniomycetes. Late discoveries have rendered the term of somewhat equivocal value; and it is not yet sufficiently distinguished from STYLOSPORES and SPERMATIA. Physiologically, they are regarded as equivalent to the gonidia of Lichens.

CONIFERÆ.—A class of Gymnospermous plants, so called from the peculiar form of the female inflorescence, in which the flowers are collected into imbricated cones; this is the case at least in the Abietineæ and Cupressineæ: in the Taxineæ, which are separated by some authors, the female flowers are solitary. These plants are remarkable in many respects. The processes occurring in the fertilization of the ovules are quite different from those in the Angiospermous flowering plants, and form a link with the conditions in the higher Flowerless plants. (See GYMNOSPERMIA.) The pollen (Pl. 40. fig. 16) is of a remarkable form in the Abietineæ. The most striking point, however, in relation to the

microscopic structure, is the condition of the stems of these plants. The wood is entirely composed of prosenchymatous cells, of large size, without intermixture of ducts or vessels; and those walls of the cells parallel with the medullary rays (very rarely those at right angles) are marked with one or more rows of the peculiar bordered pits which have been wrongly called glands (Pl. 1. fig. 4). The structure of these is explained under the head of PITTED STRUCTURES. It must be understood, however, that the peculiarity of Coniferous wood does not depend on the presence of these, which are common, but on the simultaneous absence of *ducts*. The wood of the Yew presents in addition a spiral fibre, between the coils of which the pits lie. (See TAXUS.) These peculiar conditions of the wood render it possible to identify it in microscopic sections in a recent, and, if tolerably well preserved, even in a fossil state; the Coniferous structure may be readily detected in silicified wood, in which almost all trace of organic matter is lost, the silica forming complete *casts* of the microscopic structures. This is beautifully seen in some silicified wood brought from Australia by Dr. Hooker, parts of which are so friable, that microscopic sections may be obtained by splitting it with a knife (Pl. 25. fig. 33). With solid silicified wood, sections made by the lapidary are required. We have also readily detected the structure in COAL by the process we have given under that head.

The only case of a structure approaching near enough to that of Coniferous wood to lead to misconception, appears to be that of the wood of certain Magnoliaceæ, such as *Drimys*, *Sphærostema*, and *Tasmannia*, where there is likewise absence of ducts and vessels, while the prosenchymatous cells have bordered pits; but the wood differs considerably in the character of the medullary rays, and in the number and arrangement of the pits on the walls of the cells. (See WINTERÆ.)

The wood of many of the Conifers is traversed by turpentine-canals, which are large intercellular passages bounded by thin-walled cells; in others these occur only in the bark, while in *Taxus* and *Torreya* both are devoid of them: where none occur in the wood, there are generally isolated rows of cells filled with secretions; but not even these occur in the wood of *Abies pectinata*.

The following analysis of the structure of the wood of some of the most important, is slightly modified from Hartig:—

A. *Cells of the pith with thin walls.*
- *a. Liber-cells in cross-section broad and mostly short, isolated in scattered groups, or in bands of several rows, or wanting* — ABIETINEÆ.
  - *Wood with turpentine-canals.
    - †Medullary rays with varying pits — *Pinus.*
    - ††Medullary rays with uniform pits.
      - ‡Cords of secretion-cells at the outer limit of the annual rings.
        - §Outer wood-cells of the annual rings smooth within... — *Cedrus.*
        - §§Outer wood-cells of the annual rings with an obscure spiral fibre — *Larix.*
      - ‡‡Wood without isolated rows of secretion-cells — *Picea.*
  - **Wood without turpentine-canals.
    - †Medullary rays with distant pits.
      - ‡Wood-cells with distant pits, 1 or 2 rows in pairs — *Abies.*
      - ‡‡Wood-cells with crowded pits, 1–5 rows, in spiral arrangement.
        - §Wood without cords of secretion-cells — *Araucaria.*
        - §§Wood with cords of secretion-cells — *Cunninghamia.*
    - ††Medullary rays with crowded pits — *Dammara,*
- *b. Liber-cells with square or oblong cross-section, in concentric rows, alternating with parenchymatous cells* — TAXINEÆ and PODOCARPEÆ.
  - *Pith with thick-coated liber-cells. — *Salisburia.*
  - **Pith without thick-coated liber-cells.
    - †Wood-cells with openly-coiled spiral fibre — *Taxus.*
    - ††Wood-cells smooth within.
      - ‡Liber-layers with thick-coated cells — *Podocarpus.*
      - ‡‡Liber-layers without thick-coated cells — *Dacrydium.*

B. *Cells of the pith with thick walls, liber-cells square* — CUPRESSINEÆ.
- *Liber-cells without pit-canals.
  - †Pith with a roundish cross-section, bark without turpentine-canals... — *Taxodium.*
  - ††Pith with quadrangular cross-section, bark with turpentine-canals — *Thuja.*
- **Liber-cells with pit-canals.
  - †Wood-cells smooth inside.
    - ‡Pith 3-angled — *Juniperus.*
    - ‡Pith 2- or 4-angled — *Cupressus.*
  - †Wood-cells with a spiral fibre, like *Taxus* — *Callitris.*

BIBL. Göppert, *De Conifer. Struc.* 1841; *Anat. Magnoliac.* Linnæa, xvi. 135, *Ann. Sc. Nat.* 2 sér. xviii.; Hartig, *Botan. Zeit.* vi. 123, 1848; Schacht, *Pflanzenzelle*, 435; Henfrey-Masters, *Bot.* 358, 625; Sachs, *Bot.* 496.

CONIO'CYBE, Ach.—A genus of Caliciei (Lichenaceous Lichens), distinguished by the yellow powdery thallus,

globose yellow powdery stipitate head-like apothecia, and colourless spores.

5 European, 3 British species.

Bibl. Leighton, *Lich. Fl. G. B.* 45.

CONIOMYCETES.—A section of Fungi composed of microscopic forms, for the most part parasitical upon plants, growing beneath the epidermis, or overgrowing decaying vegetables, and then more or less imbedded in the matrix. The fructification consists of groups of sessile or stalked spores (*sporidia*, Fries, and *stylospores*, Tulasne) arising from the filamentous mycelium. In the simplest forms the mycelium consists of short filaments, which are more or less completely converted into spores; or it forms an irregular flocculent patch in decaying matter or under the epidermis of plants, in which the spores are found intermingled, breaking out on the surface of the epidermis in the parasites; but in the more complete forms the mycelium becomes organized into firm structures of definite form (*conceptacles*) which are hollow, the walls being lined with short filaments terminating in spores. These conceptacles are either produced on the surface of the epidermis of the plant infested, or they are formed internally, and are exposed by breaking their way through to the surface of the epidermal structures in which they are imbedded.

We must not omit, in giving a description of this order as it stands in systematic works, to notice that recent observations go to prove that it rests upon a very insecure basis, and that certain supposed genera belonging to it appear to be merely forms of genera which exhibit at other stages of growth, or even at the same time, asciferous structures which have formed the bases of Ascomycetous genera. The following is a summary of the views of Tulasne on these points:—The Hypoxylous Fungi possess at least four distinct kinds of organs of reproduction, among which the *conidia* hold the first rank; these are bodies of various forms arising directly from the mycelium, or from the *stroma* which is formed upon this. Conidiiferous forms of Sphæriacei, which have been regarded as autonomous Fungi, have given origin to the following genera of this order:—*Melanconium, Stilbospora, Steganosporium, Coryneum, Exosporium, Cylindrosporium, Macrosporium, Vermicularia, Mystrosporium, Cladosporium, Helminthosporium, Periconium, Polythrincium, Tuberculæria, Stilbum, Atractium, Graphium.* The *stylospores* are the naked and primitive stipitate spores formed in the conceptacles, called by Tulasne *pycnidia*; he regards as pycnidial forms of Sphæriacei most of the species of the genera *Diplodia, Sporocadus, Sphæropsis, Hendersonia, Myxocyclus, Phyllosticta, Phoma*, and their allies. These forms almost always occur united with the perfect or Ascomycetous forms to which they are to be referred. A *third* kind of acrogenous bodies occur often in the same conceptacles as the stylospores, but are much smaller, ordinarily of linear form, and are usually confounded ultimately into a gelatinous mass; these are the *spermatia*, which are supposed to exercise a fertilizing influence. The genera *Cytispora, Nemaspora, Libertella, Septoria, Cheilaria, Leptothyrium*, &c., are chiefly based on the *spermogonous* apparatus of Sphæriacei. The *fourth* form of spore is found enclosed in *asci*; the presence of these *ascospores* forms the basis of the class *Ascomycetes*. Further details are given under the heads of the families, and genera there referred to.

The Uredinei exhibit similar polymorphism; since the genera there included, such as *Æcidium, Puccinia*, based upon the most perfect form of fruit, mostly exhibit also a stylosporous form (on which is founded the false genus *Uredo*), together with *spermogonia* containing *spermatia*.

Synopsis of the Families.

Phragmotrichaceæ. Conceptacles horny, breaking through the epidermis of leaves, &c., at first closed, afterwards bursting longitudinally; spores septate, and in chain-like series, intermixed with paraphyses on the internal walls of the conceptacles.

Torulacei. Mycelium filamentous, growing on the surface of decayed vegetables, bearing erect filaments, terminating in rows of simple or compound spores.

Uredinei. Mycelium a filamentous mass growing in the interior of living vegetable structures, finally breaking out on the surface in patches, margined or naked, and bearing simple or compound spores, single or in beaded series.

Ustilaginei. Mycelium filamentous, growing in the interior of organs of plants, producing simple or septate spores, finally breaking up, without bursting through to the surface, so as to leave a cavity full of dust-like spores.

Bibl. Berkeley and Broome, *Hooker's*

London Journ. of Bot. iii. 320; Tulasne, *Compt. Rendus*, March 1851 (*Ann. N. H.* 1851, viii. 114); *Ann. Sc. Nat.* 3 sér. xv. 370, xx. 129, 4 sér. ii. 77, v. p. 108; *Botan. Zeit.* xi. 49; *Compt. Rend.* 1854 (*Ann. N. H.* 2 ser. 1854, 76); Fries, *Syst. Mycol.*; De Bary, *Brand-Pilze*, Berlin, 1853.

CONIO'PHYTUM, Hassall (*Dolichospermum*, Ralfs).—A genus of Nostochaceæ (Confervoid Algæ), consisting of one species; colouring large sheets of water of a deep coppery green, by its minute fronds, each composed of a number of filaments variously curled and interwoven, densely in the centre, and more loosely towards the circumference; these fronds being free, look like a pulverulent or granular accumulation in the water, when viewed by the naked eye. The genus differs from its allies in the relative positions of the spermatic and vesicular cells, the former being either next to, or at a distance from the latter. This fact seems to throw some doubt on the value of this character as a distinctive mark.

C. Thompsoni, Ralfs (Pl. 3. fig. 9), = *Dolichospermum Thomp.*, Ralfs, *Ann. N. H.* 1850, v. 336, pl. 9. fig. 3. *Anabaina Flos-aquæ*, Harvey, *Brit. Algæ*, ed. 1; Hassall, *Algæ*, pl. 75. f. 2; also *Bot. Gaz.* 1850 (*Colour of the Serpentine*).

CONIOTHE'CIUM, Corda.—An obscure genus of Torulacei (Coniomycetous Fungi); the so-called species being probably forms of some other Fungi.

C. amentacearum is extremely common on dead willow-twigs.

Bibl. Berk. and Broome, *Ann. N. H.* 1850, v. 460; Corda, *Ic. Fung.* i. figs. 21, 25, 26; Fries, *Summa Veget.* 523.

CONIOTHY'RIUM, Corda.—A genus of Sphæronemei (Stylosporous Fungi).

C. glomeratum, Corda, recorded by Berkeley and Broome as British, is said by Fries to belong to his genus *Clisosporum*. It is a microscopic plant growing in the cracks of dead wood (elm); composed of minute free membranous peridia enclosing numerous spores, which escape by the bursting of the apex.

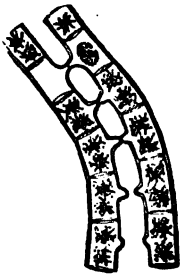
Bibl. Berk. and Broome, *Ann. N. H.* 1854, xiii. 400; Corda, iv. f. 208; Fries, *Summa Veget.* 522; Montagne, *Ann. Sc. Nat.* 3 sér. xii. 304.

CONJUGA'TION or ZYGO'SIS. — A process occurring among many of the lower plants and animals, in which the substance of two distinct organisms comes into contact and becomes fused into a single mass, or zygospore. This operation is always connected with reproduction in plants, sometimes also in animals.

In the vegetable kingdom it has been observed in the Algæ, viz. in the Zygnemaceæ, the Desmidiaceæ, the Diatomaceæ, the Palmellaceæ, and in the genus *Syzygites* of Fungi; also in the Myxomycetes. It also occurs in the zoospores. In all these cases it consists essentially in the blending together of the contents of two distinct cells: either by the complete fusion of two free cells; by the passage of the contents of one cell into the cavity of another through newly-formed connecting tubes; or by the emission of the contents of both cells into a space between them, where the mixed contents become enclosed in a special envelope.

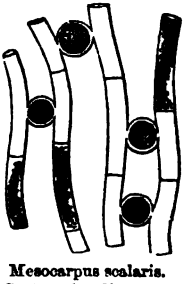
The conjugation earliest discovered was that of the Zygnemaceæ, in which the cells of distinct filaments lying parallel with one another, become united by lateral inosculation or by cross branches, formed by the budding out of the walls of the cells opposite to each other, the protruded processes coming into contact, cohering and becoming confluent by the absorption of the surfaces of contact (fig. 137). The cavities of the two cells being thus freely opened into one another, the contents become mixed; in *Spirogyra* and *Zygnema* the contents of one of the cells usually travel across into the cavity of the other (Pl. 9. fig. 18); in *Zygogonium* the contents of both cells collect in the cross-piece, this is the case also in *Mesocarpus* (fig. 138) and *Staurocarpus*, in the latter of which the cross-piece becomes greatly enlarged. The contents in all these cases become retracted from the cell-wall, and, secreting

Fig. 137.



Zygnema cruciata. Conjugating filaments. Magnified 250 diameters.

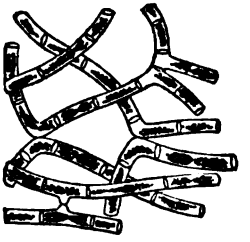
Fig. 138.



Mesocarpus scalaris. Conjugating filaments with spores. Magnified 200 diameters.

special coats, become spores, which escape by the rupture of the conjugated cells. In *Mougeotia* (fig. 139) there is no cross-branch. The filaments become angularly bent and inosculate at the angles. A spore is said to be formed in each cell here. (See ZYGNEMACEÆ.)

Fig. 139.



Mougeotia genuflexa. Conjugating filaments. Magnified 100 diameters.

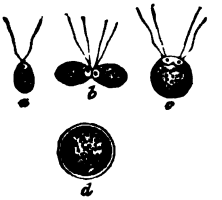
Pseudo-spores are sometimes formed in the cells of Zygnemaceæ without conjugation, in which case they are barren.

In the Desmidiaceæ, the process presents a number of modifications. In the filamentous forms, such as *Hyalotheca* and *Didymoprium*, conjugation does not usually take place until the single cells of the filaments have become separated; but in some cases, as in *D. Borreri*, conjugation of the filamentous groups has been observed, perhaps this occurs in *Desmidium* also. In *Closterium*, *Penium*, *Tetmemorus*, *Cosmarium*, &c., the free cells conjugate in pairs. In almost all these cases the mode of union appears to be different from that which is seen in Zygnemaceæ; for the external membrane dehisces more or less completely, so as to separate the parent-cells into two valves, while a delicate internal membrane previously lining this is protruded as a sac, to meet its fellow from the corresponding conjugating individual; these sac-like processes coalesce, and thus the contents of the cell are enabled to mix. In *Hyalotheca dissiliens* and *Penium Brebissonii*, there is said to be union of the primary or outer cell-coat, as in *Zygnema*. The resulting spore or sporangium is mostly formed in the connecting piece (*Closterium*, *Cosmarium*, *Tetmemorus*, *Hyalotheca*) (Pl. 10. figs. 1–3); or in one of the cells (*Didymoprium Grevillii*, and perhaps in *Desmidium*). In *Closterium lineatum* it has been observed that the conjugating cells divide completely by constriction of their delicate internal membrane just before conjugation, so that the dehiscent primary membranes emit from each parent individual a pair of little sacs, in close apposition; and these meeting their fellows, a double or *twin* conjugation takes place, and a *pair* of spores or sporangia are formed. A gelatinous investment is secreted around the conjugating sac-like processes, and the spore is generally at first imbedded in an abundant gelatinous coat. (See DESMIDIACEÆ.)

In the Diatomaceæ there does not appear to be any delicate internal membrane, like that of the Desmidiaceæ, concerned in the conjugation. The two conjugating individuals, lying near together, become connected together by the excretion of a collection of gelatinous substance; the siliceous coats then dehisce, and the contents of the parent-cells, escaping from the valves, meet between them to unite into a globular mass, which does not become a spore, but gradually acquires the form of the parent. There is no connecting tube here; only the investing gelatinous matter. In *Himantidium* and *Surirella*, one new individual is formed in the conjugation (Pl. 10. fig. 5); in *Eunotia*, *Cocconema*, *Gomphonema*, and *Schizonema*, the contents of the parent-cells appear to divide *transversely* before extrusion, and thus form a pair of new individuals in the conjugation (Pl. 10. fig. 6) (as in the case of the spores of the *Closterium lineatum*). A peculiar condition occurs in other genera (*Cyclotella*, *Melosira*, &c.), which is supposed to be a conjugation of the divided contents of one frustule. (See DIATOMACEÆ.)

Among the Palmellaceæ, conjugation has been observed in *Coccochloris Brebissonii* (*Palmoglœa macrococca*, Braun), where two vegetative cells become completely fused, membrane and contents, to form a spore which acquires a firm coat and oily contents, and passes through a stage of rest before recommencing vegetative development (Pl. 7. fig. 6, *c*, *d*).

Fig. 139*.



Pandorina morum. Conjugation of zoospores. Magnified 300 diameters.

The zoospores of *Pandorina* conjugate much as in *Coccochloris*; they approximate by their apices (fig. 139*, *b*), become fused (*c*)

then lose their cilia, and acquire a red colour, finally forming a resting spore (*d*).

The supposed conjugation of VAUCHERIA and similar phenomena in some other Confervoids, are cases of fecundation of sporangial cells by *unlike* antheridial cells, no permanent union taking place.

The well-known case of conjugation in the Fungi described by Ehrenberg in SYZYGITES, a genus of Mildew Fungi, is described under that head. See also MYXOMYCETES.

De Bary, Tulasne, and others have observed in several Fungi, as *Erysiphe*, *Pyronema*, *Peranospora*, &c., a sexual process which is exactly analogous to what takes place in certain Algæ, and in the abnormal *Saprolegniæ*; the body containing the male element coming into contact with the female organ, and thus producing fruit. This process seems rather to come under the term copulation than conjugation.

The conjugation observed in the animal kingdom, consists in the direct union, by a more or less extensive, sometimes complete, fusion of the substances of two or more distinct individuals. In *Diplozoon paradoxum* the two individuals become united by a cross branch; and the remarkable result is that sexual organs become developed in both bodies after this. Apparent conjugation takes place also in *Actinophrys*, *Acineta*, *Gregarina*, &c. It is, however, probable that the fusion which occurs in many of these cases is spurious, and unconnected with reproduction.

Podophrya pyrum is one of the best instances of true conjugation, the resulting compound individual containing 8 embryos in a single cavity common to both. The true process has also been observed in *Acineta* (*mystacina*), *Vorticella* (*microstoma*), *Paramecium*, several Flagellata, &c. The researches of Balbiani tending to show that in many of the Infusoria the conjugation is a true sexual process, have not been confirmed.

BIBL. Vegetables: Vaucher, *Conferves*; Meyen, *Pflan.phys.* iii. 413; Hassall, *Algæ*; Kützing, *Phyc. gen.*; Ralfs, *Desmid.*; Morren, *Ann. Sc. Nat.* 2 sér. v. 257; Smith, *Brit. Diat.*; Thwaites, *Ann. N. H.* xx. and ser. 2. i. and iii.; Braun, *Rejuv.* (*Ray Society*, 1853); Focke, *Physiol. Studien*, ii.; Nägeli, *Algen-Syst.* 175; Karsten, *Bot. Zeit.* x. 89; Ehrenberg *Verhandl. Naturf. Freund.* i. 98; Areschoug, *Swed. Trans.* 1853; *Bot. Zeit.* xiii. 364; De Bary, *Conjugatæ*, 1859; Griffith, *Ann. N. H.* 2 ser. xvi. 92; Carter, *ibid.* xvii. 1; Hoffmann, *Phys. Bot.* ii. 155 &c.; De Bary, *Ann. Sc. N.* 1866, 343; Tulasne, *l. c.* 1866, 211; Rostafinsky, *Bot. Zeit.* 1871, 787. Animals: Kölliker, *Sieb. u. Köllik. Zeitsch.* i. 1, 198 (*Qu. Mic. Jn.* i. 98); Siebold, *ibid.* i. 270, iii. 62; Stein, *Infus.*; *Wiegmann's Archiv*, 1849, 147; Nordmann, *Mikr. Beiträge*, i. 56; Clapar. & Lachm. *Infus.* ii. 222; Allman, *M. M. Jn.* 1875, xiv. 178; Kent, *Inf.* 92.

CONJUNCTI'VA. See EYE.

CONNECTIVE TISSUE, OF ANIMALS, sometimes called areolar or fibro-cellular tissue.

Connective tissue is very generally diffused throughout the bodies of vertebrate animals, filling up the interspaces between the various organs and structures, and entering into the composition of most of them.

There are several varieties.

The fibrous or areolar variety consists essentially of white fibrous tissue, mostly containing the elements of the yellow or elastic tissue. The most common form of the white fibrous element is that of minute, delicate, transparent fibres, called fibrillæ, with pale outlines (Pl. 49. fig. 41); these are sometimes single, at others united into bundles or fasciculi. The fibres as well as the bundles sometimes pursue a straight course; at others they are elegantly curved and wavy, interlacing in all directions, and leaving larger or smaller areolæ or spaces between them, the larger of which are visible to the naked eye. The fibrillæ are about 1-40,000 to 1-20,000″, and the fasciculi about 1-7000 to 1-3000″ in diameter. In the fasciculi, the fibres are connected by an amorphous, transparent, gelatinous substance. Intermingled with the fibres, are rounded, elongate, or branched cells (connective corpuscles) or nucleated protoplasts, which may be well examined in the transparent laminæ separating the muscles of a frog's leg. Some of these are stationary, but exhibit changes of form. Others are locomotive, with amœboid movement, and correspond to the white blood-corpuscles. The connective corpuscles may often be rendered more distinct by staining with magenta. When treated with acetic acid, the fibres swell, become paler, and lose their distinctness, the bundles appearing as if fused into a gelatinous mass (fig. 29. p. 69); and round or elliptical nuclei, with their long axes parallel to the direction of the

fibres, are brought to view, as in Pl. 49. fig. 42.

The retiform variety consists of a very delicate network of fine fibrils, formed originally by the union of branched connective-tissue corpuscles. This constitutes the stroma of the spleen, and the lymphatic glands. A still finer variety form the Neuroglia.

The yellow fibrous tissue occurs in the form of fine or coarser fibres, with dark outlines; these sometimes run straight, or are wavy or reticular; at others they are coiled or form rings around the bundles of the areolar tissue, or running parallel with and between them, sometimes forming perforated membranes. They are best seen when the tissue has been rendered transparent by the addition of acetic acid.

In the gelatinous or mucous variety, the intercellular substance forms a soft semi-transparent mass, containing rounded spindle-shaped or branched cells, often united by the branches; it is met with in the Invertebrata, as the *Medusæ*, the integument of the Mollusca, &c.

The truly cellular form, which is also common among the Invertebrata, consists of round or elongate cells, with but little intercellular substance; it occurs in the Articulata, the Mollusca, and in the *Chorda dorsalis*.

Connective tissue consists chemically of gelatine, which may be obtained from it in solution by boiling; elastic tissue consists of elastine.

The various complex structures into the composition of which the connective tissue enters, as the mucous membranes, skin, fatty tissue, &c., are noticed under their respective heads. Cartilage and Bone are also considered connective-tissue formations.

Connective tissue is developed from the embryonic corpuscles. These become elongated, or fusiform, and branched. They unite with each other, and the ends become split into the component fibrillæ of the future tissue. But whether the corpuscles are solid bodies or protoplasts, or true cells, is not at present agreed upon.

Bibl. Kölliker, *Gewebelehre*; Mulder-Donders, *Phys. Chem.*; Todd-Bowman, *Phys. An.*; Drummond, *Ed. Mn. Jn.* 1852; Rollett, *Stricker's Handb.* 38; Beale, *Simple Tissues*; Klein, *Hist.*; Gegenbaur, *Vergl. An.*; Frey, *Hist.* and the copious Bibl.; Kirkes-Baker, *Phys.*; Rutherford, *Histology*; Waldeyer, *Arch. f. mik. An.* 1876, ii. 176 (*M. M. Jn.* xvi. 94); Satterthwaite, *Mn. M. Jn.* 1876, xvi. 191, 241; Flemming, *Arch. An. & Phys.* 1876, xii. 391.

CONOCEPH'ALUS, Hill. See Fegatella.

CONOCHI'LUS, Ehr.—A genus of Rotatoria, of the family Œcistina.

Char. Animals aggregated around a central gelatinous nucleus, and forming a revolving sphere; two persistent frontal eye-spots.

From ten to forty in each sphere. Nucleus sometimes green, from the presence of parasitic monads. Four thick conical papillæ arise from the middle of the frontal surface, each having a bristle at its apex.

C. volvox (Pl. 43. figs. 15–17). Carapace and body white, gelatinous, and hyaline; length 1-60″, breadth of sphere 1-8″. Freshwater. 2 kinds of eggs—male and female.

Bibl. Ehr. *Infus.* 393; Davis, *M. M. Jn.* 1876, 1; Bedwell, *Jn. Mic. Soc.* 1878, i. 176.

CO'NODONTS.—Minute, slender, conical, curved, brownish bodies, found in a sandy Lower Silurian clay near Petersburg, and supposed by Pander to be minute fish-teeth. Possibly they belonged to Cyclostome fishes of extinct genera. They occur also in later strata.

Bibl. Pander, *Mon. foss. Fische*, &c., 1856; Murchison, *Siluria*, 1859, 375, and 1867, 356; Hinde, *Qu. Geol. Jn.* xxxv. 356.

CONOS'TOMUM, Sw.—A genus of Bartramiaceous Mosses. *Conostomum boreale*, Sw., on Scottish mountains.

CONULI'NA, D'Orb.—A top-shaped, many-chambered, stichostegian Foraminifer, having the septal face slightly convex and multiperforate, is the only recorded sample of this doubtful genus, which is probably related to *Lituola*.

Bibl. D'Orb. *Foram. Cuba*, 1839.

CONULI'TES, Carter.—A Foraminifer of the *Globigerinida* family, closely allied to, if not the same as, *Patellina*.

Bibl. Carter, *Ann. N. H.* ser. 3, viii. 457; Carpenter, *Introd. For.* 233.

COPE'PODA. See Entomostraca.

COPPER.—Crystals of metallic copper exist in artificial Avanturine. The acetate of copper is noticed under Acetic acid.

Copper occurs in minute quantities, in the human bile, biliary calculi, and the blood; and in the blood of some Crustacea; also in the Cephalopoda.

The ammoniuret of copper is prepared by

digesting copper turnings in an open bottle, with *Liq. Amm.* (P. B.); it must be used fresh. Its action is well displayed when it is brought into contact with cotton-wool.

COPPI'NIA, Hass.—A genus of Coppiniidæ (Hydroid Zoophytes).

Char. Cells long, crowded, united by a cellular mass at their bases; ova developed in the cavities of the cellular mass.

C. arcta. Incrusting the stems of other zoophytes, common; greenish yellow.

Bibl. Hassall, *Mic. Tr.* iii. 160; Hincks, *Brit. Zooph.* 219.

CO'RA, Fr.—A tropical genus of Lichens, approaching *Coccocarpia.*

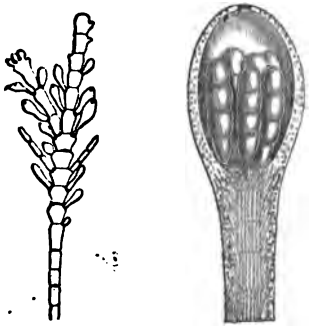
1 species: *C. pavonia.*

Bibl. Fries, *Syst. Orb. Veg.* 300; Nyl. *Ann. Sc. Nat.* 1855, iii. 151.

CORAL.—A term applied in general to the calcareous polypidom or skeleton of Polypes or Zoophytes, and in particular to that of Corallium.

CORAL'LINA, Linn.—A genus of Corallinaceæ (Florideous Algæ), of stony character, looking like corals. The common *C. officinalis* grows everywhere between tide-marks, on rocks, &c.; and presents a

Fig. 140. Fig. 141.



Corallina officinalis.

Fig. 140. A branch of the frond. Natural size.
Fig. 141. A section of the end of a branch terminating in a ceramidium, containing tetraspores. Magnified 10 diameters.

branched, mostly pinnate tuft of articulated filaments evenly coated with carbonate of lime. The tetraspores are borne in tufts in ceramidia (fig. 141), usually at the apices of the branches (being the last joints transformed); or they occur laterally (fig. 140), sometimes in pairs and sometimes irregularly over the whole frond; opening by a small terminal pore (fig. 141).

The structure may be examined in these plants, by keeping them for some time in vinegar or dilute muriatic acid; which will remove the lime, and allow of the substance being sliced in the same way as other Algæ.

Bibl. Harvey, *Mar. Alg.* pl. 13 C; *Phyc. Brit.* pl. 222; Decaisne, *Ann. Sc. Nat.* 2 sér. xvii. pl. 17. fig. 1, xviii. p. 119; Solms-Laubach, *Corall.-Algen Golf Neapel*, 1881.

CORALLINA'CEÆ.—A family of Florideæ. Rigid, articulated, or crustaceous, mostly calcareous sea-weeds, purple when fresh, fading, on exposure, to milk-white; composed of closely-packed elongated cells or filaments, in which carbonate of lime is deposited in an organized form. *Tetraspores* tufted, contained in ovate or spherical *conceptacles* (*ceramidia*, Harvey), furnished with a terminal pore. British genera:

* *Frond filiform, articulated* (Corallineæ).

Corallina. Frond pinnated. *Ceramidia* terminal, simple.

Jania. Frond dichotomous. *Ceramidia* tipped with two horn-like ramuli.

** *Frond crustaceous or foliaceous, opaque, not articulated* (Nulliporæ).

Melobesia. Frond stony, forming either a crustaceous expansion, or a foliaceous or a shrub-like body.

Hildebrandtia. Frond cartilaginous, not stony, forming a crustaceous expansion.

*** *Frond plane, hyaline, composed of cells radiating from a centre. Fructification unknown* (Lithocysteæ).

Lithocystis (a minute parasite).

CORALLINES.—The Corallinaceæ, a family of Algæ, were formerly imagined to be of animal nature, and were classed among the Zoophytes. On the other hand, Ellis applied the term *Coralline* more extensively, including under it Polyzoa (Bryozoa), and Sertularian and similar Zoophytes (Polypes); the name is still often vulgarly used in this sense. The term should properly be restricted to the family to which the genus *Corallina* gives the name.

CORAL'LIUM, Lam.—A genus of Zoophytes, of the order Actinozoa.

The red coral of commerce is the internal skeleton of *Corallium rubrum*, Lam. (*Isis nobilis*, Lin.) (Pl. 41. fig. 6 *c*). A portion of the dried animal matter is usually

found adhering to its surface, and contains abundance of spicula (Pl. 41. fig. 7).

The furrows seen upon the outer surface of unprepared coral, are the impressions of vessels which traverse the cortical substance and form a medium of communication between the various polypes.

The structure of coral is rather obscure. The transverse section (Pl. 41. fig. 8 *a*) exhibits somewhat undefined lines, some of which are semiconcentric with the marginal furrows, and appear to be lines of growth; these are intersected by darker and narrower lines, apparently canals. The orifices of larger canals are also visible. The longitudinal section (Pl. 41. fig. 8 *b*) exhibits longitudinal lines, probably those of growth, with an indistinct intermediate structure. When treated with acid, the residue is soft and easily folded so as to produce a lined appearance; and in parts the organic skeletons of spicula may be distinguished. Hence it probably consists of spicula, aggregated and ultimately consolidated, so that their structure is no longer distinguishable.

Bibl. Cuvier, *Règne Animal*, 1853, *Zoophytes*; Lacaze-Duthiers, *Hist. Nat. Corail*, 1864; Dana, *Corals*, 1872; Nicholson & Etheridge, *An. N. H.* 1877, xx. 161, 388; Milne-Edwards & Haime, *Monog. fossil* (*Pal. Soc.*); Duncan, *ibid.*

COR'DYCEPS, Fries. See Sphæria and ClavicepS.

CORDYLO'PHORA, Allman.—A genus of Zoophytes, order Hydroida, and family Clavidæ. Freshwater.

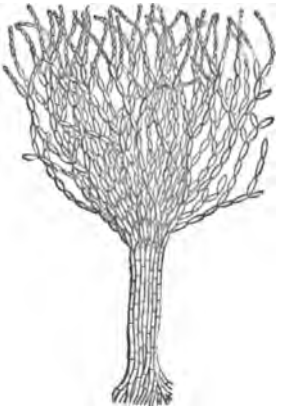
Char. Polypidom horny, branched, rooted by a creeping tubular fibre; branches tubular; polypes existing at the extremities of the branches, ovoid, the mouth at the distal extremity, and furnished with scattered filiform tentacula.

C. lacustris, the only species; height 2–3 inches. The only compound Polype found in fresh water.

Bibl. Allman, *Ann. N. H.* xiii. 330; and *Phil. Tr.* 1853; Johnston, *Br. Zoophytes*, 44; Hincks, *Zooph.* 15; *Schultze's Archiv*, 1871.

CORE'MIUM, Link.—A spurious genus of Mucedines (Hyphomycetous Fungi), not really distinct from Penicillium; but differing from the characteristic form of that genus in having the erect fertile filaments compacted into a kind of cellular pedicle to bear the strings of spores (fig. 142). *C. leucopus*, Pers.; filaments white, spores green; not uncommon on decaying fruits, &c.= *Floccaria glauca*, Grev. *Sc. Crypt. Fl.* t. 301, and is *Penicillium crustaceum* β, Fries. *C. candidum*, Nees, filaments and spores white,

Fig. 142.



Coremium niveum, Corda. Magnified 200 diameters.

on decaying substances, is *Penicillium candidum* β, Fries.

Bibl. Hook. *Brit. Fl.* v. pt. 2. 344; Fries, *Syst. Mycol.* iii. 408; Greville, *loc. cit.*; Corda, *Icones Fung.* ii. pl. 11. fig. 73; *Prachtflora*, pl. 25.

CORE'THRA, Meig.—A genus of Dipterous Insects, of the family Tipulidæ.

The larva of *C. plumicornis* forms a beautiful microscopic object; it inhabits fresh water.

Bibl. Karsch, *Monog. d. Coreth. plum.*; Ray Lankester, *Pop. Sc. Rev.* 1865; Leydig, *Sieb. & Köll. Zeitsch.* iii. 435; Rymer Jones, *Mic. Tr.* 1866, 99; Weismann, *Sieb. & Köll. Zeitsch.* 1866, 45.

CORE'THRIA, Wright.—A genus of Rhizopoda, family Actinophryina (?). Body oblong, with a long club-shaped appendage, bearing a thick brush of 8–40 tentacles at its summit.

C. sertulariæ. On *Sertularia pumila.*

Bibl. Pritchard, *Infus.* p. 563.

CORIN'NA, Heib.—A genus of Diatomaceæ.

Char. Frustules punctate-areolate, united into semicircular fasciæ, angles produced, spiniferous, the uppermost longest, intermediate portion hemispherical, with septa; valves ellipsoidal, transversely bicostate, apiculate at each end.

C. elegans. Shores of Denmark.

BIBL. Heiberg, *Consp. Diat.* 1863, 53, pl. 3. fig. 8.

CORK.—Ordinarily the outer layer of bark of the Cork Oak (*Quercus Suber*), for the development of which, see BARK. Vertical and transverse sections of the large light-coloured cells of cork are shown in Pl. 47. figs. 16 and 17. The term cork is applied generally to excessive developments of the *suberous layer* of barks.

CORN.—The general name applied to the seeds, or rather the fruits of the various plants furnishing the ordinary materials for bread. These all belong to the Monocotyledonous family, Graminaceæ (Grasses); for Buck-wheats cannot be considered as true corn. The grains of the Grasses are enveloped in the adherent pericarp, which is dry and smooth; the seed which this encloses is characterized by the presence of a comparatively larger *mealy* albumen, composed of thin-walled parenchyma, more or less densely filled with starch, which makes up the great body of the grain; a few layers of cells subjacent to the surface, however, contain little starch, but abundance of nitrogenous protoplasmic matter, or *gluten*. These layers containing the greater proportion of the gluten, together with epidermis, are removed from fine flour in grinding, as the bran and pollard—the fine white flour consisting chiefly of the starch. The forms of the starch-grains differ considerably, as also their condition in the cell (Pl. 46). In Wheat (*Triticum*), the starch-grains are lenticular (fig. 8), and lie loose in the cells; in Barley (*Hordeum*), they are very similar, but the larger grains are squarish and thinner (fig. 9); in Oats (*Avena*), polygonal, but compacted together into roundish masses (fig. 10); in Rice (*Oryza*), the starch-grains are very small, and packed so closely together that they press upon one another, thus acquiring a parenchymatous form (figs. 12 & 13); and then, as they adhere firmly together, the contents of the cells appear like one solid mass; hence the horny character of the grains of rice, and the grittiness of rice-flour. In Maize (*Zea*), the outer part of the grain is horny from the same cause as rice, and presents a similar appearance (fig. 3), but in the centre the cells are often less densely filled, and the grains lie more or less loose (fig. 5). For further particulars of the characters of the starch-grains, see STARCH.

CORNEA. See EYE.

CORNICULA'RIA, Ach.—A genus of Lichens = *Alectoria* pt.

CORNS consist of thickened epidermis, the scales being increased in number, much flattened, and closely aggregated from pressure. This is the structure in their simplest form. When larger they represent an ordinary blister, conjoined with the thickening of the epidermis; hence the origin of the cavity in the centre of many of them. The papillæ of the cutis are generally hypertrophied. The epidermic scales may be rendered distinct by digestion with acetic acid or solution of potash.

CORNUSPI'RA, Schultze.—This genus, restricted, comprises the planorbiform *Miliolida*, which, commencing with a somewhat agathistegian growth, soon become discoidal and non-segmented.

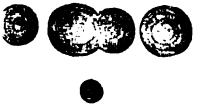
C. foliacea (Pl. 23. fig. 13) is a common Foraminifer, white and opaque, with the whorls rapidly increasing in width in the adult state. It has abounded from the older Tertiary times to the present, chiefly in shallow water, but found at 530 fathoms, North Atlantic, by Carpenter.

BIBL. Carpenter, *Foram.* 68; *Pr. Roy. Soc.* 1869; Schultze, *Ann. N. H.* 1861, 306.

COR'PORA AMYLA'CEA.—These are microscopic rounded bodies, exhibiting a number of concentric rings, and somewhat resembling starch-grains in appearance.

They are found in the *fornix*, the *septum lucidum*, the walls of the ventricles, and the cortical substance of the brain, the medullary substance of the spinal cord, the waxy spleen, &c. They are but little acted upon by dilute acids; caustic alkalies render them more transparent, and gradually dissolve them. Solution of iodine gives them a bluish tinge; and the subsequent addition of sulphuric acid produces the bluish-violet colour seen when cellulose is treated with these reagents. The reaction is best seen when the action of the acid takes place slowly. Hence these bodies have been regarded as consisting of amyloid or cellulose.

Fig. 143.



Magnified 350 diameters. Corpora amylacea, from the human ependyma.

The *corpora amylacea* must be distinguished from the concretions forming 'brain-sand,' or the *acervulus cerebri*. These are also rounded, single, or aggregated, usually

exhibiting the concentric rings, sometimes forming cylindrical, ramified, or reticular fibres. They are met with in the choroid plexuses, the pineal gland, the arachnoid membrane, and sometimes in the walls of the ventricles. These consist of an organic (proteine) skeleton, containing carbonate and phosphate of lime. When treated with acids, the latter are dissolved, the former being left and retaining the original form of the concretions.

Bibl. Purkinje, *Müller's Archiv*, 1836 & 1845; Kölliker, *Mikr. An.* ii.; Virchow, *Archiv path. An.* 135, 268, 416, and *Ann. N. Hist.* xii. 481; Green, *Pathology*, 1871, 71; Frey, *Histol.*; Rindfleisch, *Path.* 1878, 35.

CORPUS'CULA, of the Coniferæ. See Gymnospermia.

CORROSIVE SUBLIMATE, the bichloride of Mercury.—A saturated solution of this salt is very useful in rendering very transparent bodies consisting of proteine-compounds more opaque and distinct, as the bodies and cilia of Infusoria &c.

CORYCÆ'US, Dana.—A genus of Copepoda (Entomostraca).

C. anglicus. Marine.

Bibl. Brady, *Copepoda* (*Ray Soc.*), iii. 32.

CORY'CIA, Duj. = *Amœba bilimbosa*, Auerbach (Duj. *Ann. d. Sc. N.* 1852, p. 41).

CORYMOR'PHA, Sars.—A genus of marine Hydroid Polypi, family Tubulariidæ.

Bibl. Hincks, *Brit. Zooph.* p. 125.

CORYNACTIS, Allman.—A genus of Anthozoa (Zoophytes).

1 species: *C. viridis*.

Bibl. Gosse, *Actinologia Britannica* (the latest work on *Sea-Anemones*).

CORY'NE, Gærtn.—A genus of marine Hydroid Polypi, family Corynidæ.

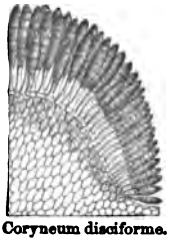
Bibl. Hincks, *Brit. Zooph.* p. 37.

CORYN'EUM, Kunze.—A genus of Melanconiei (Stylosporous Fungi), consisting of parasitic plants growing upon dead twigs, bursting out as convex solid pustules from beneath the epidermis. A vertical section of half of one of these pustules is shown in fig. 144; the cellular stroma is covered by stalked multiseptate spores. Six forms are recorded as British. That figured, *C. disciforme*, Kze., grows on dead twigs of birch.

Tulasne states this genus to consist of the conidiiferous form of *Melanconiei* (Sphæriacei).

Bibl. Hook. *Br. Fl.* v. pt. 2. 355; Berk. & Broome, *Ann. N. H.* 2 ser. v. 458; Currey, *Qu. Mic. Jn.* v. 127; Tulasne, *Ann. Sc. Nat.* 4 sér. v. 110; Corda, *Icones Fung.*

Fig. 144.



Coryneum disciforme. Vertical section of half a pustule. Magnified 200 diams.

CORYNO'PSIS, Allman.—A genus of marine Hydroid Polypi, family Hydractiniidæ.

C. Alderi. Durham.

Bibl. Hincks, *Brit. Zooph.* p. 34.

COSCINODISCUS, —Ehr. A genus of Diatomaceæ.

Char. Frustrules free, single, disk-shaped; valves circular, flat, or slightly convex, exhibiting a cellular or areolar appearance; no internal septa, nor lateral processes.

The cellular appearance arises from the existence of depressions, which are of different sizes. The valves form beautiful objects.

Kützing enumerates forty-one species, which are either marine or fossil. Smith admits four British species.

C. minor, E. Depressions irregular and crowded (circular, Sm.); margin of valves smooth; freshwater and marine; diam. 1-1200 to 1-500″.

C. radiatus, E. (Pl. 51. fig. 1). Depressions obscurely radiating, marginal ones smallest; margin of valves smooth; marine and fossil; diam. 1-550 to 1-180″ (*a*, side view; *b*, front view).

C. eccentricus, E. Depressions arranged in curved lines, with the convexity towards the centre; marine and fossil; diam. 1-400 to 1-200″.

C. pyxidicula, Kg. (*Pyxidicula* and *Craspedodiscus coscinodiscus*, E.) (Pl. 18. fig. 21). Margin tumid, elegantly cellular, central areola very fine, diminishing towards the centre; no umbilical star; marginal cells hexagonal, larger; diam. 1-400″. Fossil. Virginia.

C. craspedodiscus, K. = *Craspedodiscus elegans*, E. (Pl. 25. figs. 7, 8). Margin of valves tumid, elegantly sculptured, central markings radiating; an umbilical star formed of 5 to 6 oblong larger cells ?; diam. 1-120″. Fossil. Bermuda.

C. oculus iridis. Areolæ hexagonal, with central "eye-spots."

Bibl. Ehr. *Abhandl. Berl. Ak.* 1838 and 1839; id. *Ber. Berl. Akad.* 1840 *et seq.*; Kützing, *Bacill.* and *Sp. Alg.*; Smith,

Brit. Diat. 1; Wallich, *Qu. Mic. Jn.* 1860, 38; Greville, *Mic. Trans.* 1864, 9; 1865, 25, 43; 1866, 3, 78.

COSCINOSPI'RA, Ehrenberg.—The elongate subtype of *Peneroplis*, one of the *Foraminifera imperforata*. It is a synonym of *Spirolina*, Lamarck.

Bibl. Ehrenberg, *Tr. Berlin Ac.* 1839; Parker and Jones, *Ann. N. H.* ser. 3, v. 180.

COSMARIUM, Corda.—A genus of Desmidiaceæ.

Char. Cells single, constricted at the middle; segments as broad as or broader than long, neither sinuated nor spinous.

A peculiar swarming motion is observable at times in the cell-contents of this genus, different from the circulation in *Closterium*. From some observations by Mrs. Thomas, it appears that the spore-cell divides into numerous individuals in germination.

Rabenhorst describes 77 European species. Among the most common British species are:—

C. pyramidatum (Pl. 14. fig. 18, 19 empty cell). Oval, with depressed and truncate ends, deeply constricted; end view elliptical; segments punctate, entire; length 1-470 to 1-260″.

C. bioculatum. Smooth, depressed, constriction producing a gaping notch on each side; end view elliptical; segments subelliptic, entire; sporangium orbicular, spinous; length 1-1410″.

C. crenatum (Pl. 14. fig. 20). Punctate, deeply constricted; segments crenate at the margin, depressed at the end; end view elliptical; spines of sporangium very short; length 1-470″.

C. tetraophthalmum (Pl. 14. fig. 22). Deeply constricted; segments semicircular; end view elliptical; rough with pearly granules, which give a crenate appearance to the margin; length 1-230″.

C. margaritiferum (Pl. 14. fig. 21). Rough with pearly granules, which are as broad as long; end view elliptic; segments semicircular or reniform; length 1-560 to 1-300″.

C. ornatum. Segments twice as long as broad, rough with granules giving a dentate appearance to the margin; end view with a truncate projection on each side; length 1-610″.

C. cucurbita. Punctate, constriction slight, ends rounded; transverse view circular; length 1-580″.

Lobb describes an extraordinary species, *C. radiatum*, the surface being covered by densely crowded hyaline filaments, like those of *Actinophrys*, but closer.

Bibl. Ralfs, *Desmid.* 91 & 212; Thomas, *Mic. Tr.* new ser. iii. 33; Lobb. *Qu. Mic. Jn.* 1866, 55; Archer, *Qu. Mic. Jn.* 1860, 235, 1864, 178.

COSMIODIS'CUS, Grev.—A genus of fossil Diatomaceæ.

Char. Frustules simple, disk-shaped; valves radiato-punctate or areolar, with linear radiating spaces (no processes nor internal septa). 3 species: in Monterey and Barbadoes deposit.

Bibl. Greville, *Qu. Mic. Jn.* 1866, 79.

COSMOCLA'DIUM, Bréb.—A genus of Desmidiaceæ (Palmellaceæ, Rab.).

Char. Cells rounded, compressed, deeply constricted, attached to a branched stipes. Reproduction by gonidia.

C. pulchellum (Pl. 51. fig. 38), attached; in turfy pools.

2 other species (unattached).

Bibl. De Bréb isson, *Liste d. Desm.* 133; Rabenhorst, *Fl. Alg.* iii. 53.

COTHURNIA, Ehr.—A genus of Infusoria, of the family Vorticellina, subfamily Ophrydina.

Char. Solitary; carapace urceolate, stalked, fixed by the posterior extremity.

An anterior ring of cilia is present. The body contracts suddenly, like that of *Vorticella*.

Dujardin unites this genus with *Vaginicola*.

C. imberbis, E. (Pl. 32. fig. 20). Stalk much shorter than the hyaline carapace; body yellowish; aquatic; length of carapace 1-280″. Found upon *Cyclops quadricornis*.

C. maritima, E. Stalk much shorter than the carapace; body whitish, hyaline; length of carapace 1-570″. On *Ceramium*.

C. havniensis, E. Stalk much longer than the carapace; body whitish; length of carapace without the stalk 1-280″, stalk twice this length. On *Sertulariæ* &c.

Stein adds 3 species, *C. Sieboldii*, *C. astaci*, and *C. curva*; found upon *Astacus fluviatilis* (the Cray-fish). Cl. & L. describe 12 species, 4 new.

Bibl. Ehr. *Inf.* 297; Duj. *Inf.* 564; Stein, *Infus.*; Clap. & Lachm. *Infus.* i. 121; Kent, *Inf.* 719; Hutton, *Jn. Mic. Soc.* 1878, i. 49.

COTTON.—The hairs from the epidermis of the seeds of various species of *Gossypium* (Malvaceæ, Dicotyledons). These hairs are readily distinguished under the microscope

from the various textile fibres consisting of liber structures. From the absence of the regular thickening layers, the cells of the cotton-hairs become collapsed when dry, appearing like a flat band with thickened borders, while liber-cells of all kinds remain cylindrical, and taper to a point at each end (Pl. 28. fig. 1). See FIBROUS STRUCTURES; and Mitchell, *Qu. Mic. Jn.* 1864, 218.

COVERS. See INTRODUCTION, p. xxiv.

CRASPEDODISCUS, E.—A genus of fossil Diatomaceæ.

C. coscinodiscus, E. = *Pyxidicula coscinodiscus*, E. = *Coscinodiscus pyxidicula*, Kg. (Pl. 18. fig. 21).

C. elegans, E. = *Coscinodiscus craspedodiscus*, Kg. (Pl. 25. figs. 7 & 8).

BIBL. Ehr. *Ber. d. Berl. Ak.* 1844, 261–266; Kützing, *Sp. Alg.* 126; Greville, *Mic. Trans.* 1866, 79; Pritchard, *Inf.* 831, 939.

CRASPEDO'PORUS, Grev.—A genus of Diatomaceæ.

Char. Frustules free, disk-shaped; valves with club-shaped rays, each with an ocellus near the margin.

C. Ralfsianus. Valves areolar, rays 8; diam. 1-220″. Barbadoes.

C. Johnstonianus. Rays 5; diam. 1-400″. Barbadoes.

BIBL. Greville, *Mic. Trans.* 1863, 68.

CRATERIUM, Trent.—A genus of Myxomycetes, consisting of minute yellow or brown cup-like bodies, of papery consistence, closed by a deciduous operculum (fig. 145); arising from an evanescent gelatinous mycelium, growing over moss, leaves, bark, &c. Most of the species are common. The black spores contained within these cups are intermixed with crowded, obscurely articulated filaments (destitute of spiral fibres), which do not anastomose, and are at length erect. Five British species. A. Murray's remark upon *Craterium*, that it is an *Acarus*, applies to *Atractobolus*.

Fig. 145.

Craterium pyriforme. Magnified 10 diameters.

BIBL. Hook. *Brit. Fl.* v. pt. 2. 316; Sowerby, *Fungi*, t. 239 (*C. minutum*, as *Cyathus minutus*).

CRATEROSPER'MUM, Braun.—A genus of Zygnemaceæ, with the green endochrome not in spiral bands. Conjugating filaments geniculate; sporange or zygospore with a double cyst; the inner spherical, the outer thick, shortly cylindrical, subquadrate, with an annular furrow, and excavated at each pole.

C. lætevirens (Pl. 3. fig. 10). In pools.

BIBL. Braun, *Alg. Unicell.* 1855, 60; Rabenhorst, *Fl. Alg.* iii. 258 (fig.).

CREATINE or KREATINE.—Occurs in the juice of the flesh of Mammals, Birds, Amphibia, and Fishes; in exudations, in the amniotic liquid, the blood, and the brain. It crystallizes from an aqueous solution, in transparent, highly refractive, oblique-rhombic prisms and needles (Pl. 11. fig. 22) belonging to the oblique-rhombic prismatic system.

CREATININE or KREATININE.—Occurs in the urine of man and of Mammalia. The crystals form colourless prisms belonging to the oblique-rhombic prismati system (Pl. 11. fig. 23).

Creatinine forms a crystallized compound with chloride of zinc (Pl. 11. fig. 24). This is very difficultly soluble in water, and not at all in alcohol or ether.

CRE'NOTHRIX, Cohn.—A genus of Oscillatoriaceæ (Confervoid Algæ).

Char. Filaments narrow, jointed, arcuate or twisted into little free or adherent tufts; with hyaline sheaths; endochrome homogeneous; sporanges terminal. Microgonidia formed from a row of cells by successive division, rounded, very minute, crowded, and without cilia. Macrogonidia of the entire or 2–4-divided cell-contents. Intermediate between *Lyngbya* and *Chamæsiphon*.

C. polyspora. In wells and springs.

BIBL. Cohn, *Beit. Biol.* i. 108.

CRESSWEL'LIA, Grev.—A genus of fossil Diatomaceæ.

Char. Frustules cylindrical, cohering by short filiform (spine-like) processes into a continuous filament. Valves cup-like, areolar, destitute of siliceous connecting band or hoop.

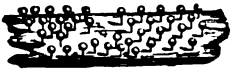
C. turris. Clyde. Other species.

BIBL. Greville, *Edin. Ph. Tr.* 1857, xxi. 538; *Mic. Tr.* 1861, 68; 1865, 4; 1866, 78.

CRIBRA'RIA, Schrad.—A genus of Myxomycetes (Gasteromycetous Fungi), consisting of minute stalked capsules growing upon rotten wood &c. The capsules (peridia) are membranous; the upper part falls or decays off when the spores are mature; and the anastomosing filaments

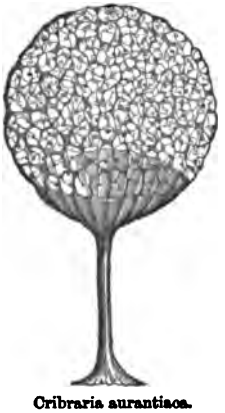
(capillitium) which are contained in the interior, are confluent with the outer wall, where they form a permanent spherical cage or network (fig. 147), from the meshes of which the spores escape. The three or four species recorded as British, are *C. intermedia*, Berk., intermediate between *C. vulgaris* and *C. aurantiaca*. The peridium is yellow with a white stalk; the spores yellow. (Figured as *Sphærocarpus semitrichioides* by Sowerby, t. 400. fig. 5.) To this have recently been added *C. argillacea*, *aurantiaca*, and *intricata*. They are very interesting microscopic objects.

Fig. 146.



Cribraria aurantiaca. Natural size.

Fig. 147.



Cribraria aurantiaca. Peridium burst, with the capillitium exserted. Magnified 25 diameters.

BIBL. Hook. *Brit. Fl.* v. pt. 2. 318; Fries, *Syst. Mycolog.* iii. 168; Corda, *Icon. Fung.* v. pl. 3. fig. 35; Cook, *Handb.* 400.

CRIBRILI'NA, Gray.—A genus of Cheilostomatous Polyzoa (Bryozoa), = *Lepraliæ* with the front cells occupied by transverse or radiating punctured furrows. 5 species. On shells and Algæ.

BIBL. Hincks, *Polyzoa*, 184.

CRICKET. See ACHETA.

CRIS'IA, Lamx.—A genus of Crisiidæ, Cyclostomatous Polyzoa.

Char. See CRISIIDÆ. Three species.

C. cornuta. Cells curved, orifices turned one way; a long bristle above each cell.

C. eburnea. Cells loosely aggregated, curved, ends free. Common.

C. denticulata. Cells loosely aggregated, nearly straight, joints black.

CRISIIDÆ.—A family of Cyclostomatous Polyzoa.

Distinguished by the plant-like jointed and branched calcareous polyzoary and the tubular cells in one or two rows, with round orifices mostly looking to opposite sides.

Cells and branches covered with dots Pear-shaped vesicles are met with on the polypidom, resembling those of the Sertulariidæ.

Crisia. Cells in one or two rows, subalternate; orifices terminal and entire.

BIBL. Johnston, *Br. Zooph.* 382; Hincks, *Polyzoa*, 418.

CRISTATEL'LA, Cuv.—A genus of Cristatellidæ, Polyzoa (Bryozoa).

Char. Polyzoary free, disk-shaped, polypiferous at the margin; tentacles numerous, pectinate upon two arms. Freshwater.

C. mucedo (Pl. 41. fig. 9). Three, four, or more polypes arise from the locomotive polypidom. Pseud-ova (statoblasts) in the young state enclosed in a ciliate membrane, disk-shaped, furnished with marginal spines which are hooked at the end (fig. 10), and opening with a lid.

In clear lakes and ponds, creeping over stones and the stems of aquatic plants; and occasionally in large numbers in the holes made by the feet of cattle around ponds. Length $1\frac{1}{2}''$, breadth $\frac{1}{4}''$.

BIBL. Cuvier, *Règne Animal*, 1817, iv. 68; Turpin, *Ann. d. Sc. Nat.* 2 sér. vii. 65; Gervais, *ibid.* vii. 77; Johnston, *Br. Zooph.* 387; Varley, *Lond. Phys. Journ.* iii. 37; Allman, *Polyzoa* (*Ray Soc.*).

CRISTELLA'RIA, Lamk.—Among the hyaline Foraminifera grouped generically as *Nodosarina* and varying in mode of growth from straight and partially curved to discoidal, the *Cristellariæ* are the more symmetrically lenticular and nautiloid, varying, however, in outline and in thickness. The chambers, either triangular or falciform, are close-set and communicate at the outer angle. The shell is neat, often delicate, and ornamented on the margin with keel or *crest*, and on the sides with raised umbones, granulations, cross bars, and septal ridges.

Cristellaria is common in the Lias and all succeeding formations, very large in the Tertiary deposits of Italy, and not uncommon in existing seas. *C. simplex* (Pl. 23. fig. 34), feeble of growth, is present always with other *Cristellariæ*. *C. cultrata* (fig. 37) is a well-grown and typical form.

BIBL. D'Orbigny, *For. Foss. Vien.* 82; Morris, *Brit. Foss.* 33; Williamson, *Rec. For.* 24; Parker and Jones, *Ann. N. H.* 2 ser. xix. 209; 3 ser. iii. 477; v. 114; Carpenter, *Foram.* 162.

CRONAR'TIUM, Fries.—A genus of Uredinei (Coniomycetous Fungi), presenting the most perfect form of structure in

that family. The spores are contained in a peridium, which bursts by a regular or irregular apical orifice. The perfect spores are produced on a columnar cellular body, called the ligule, which rises out of the centre of the Uredo-form or of its empty perithecium. *C. Vincetoxici* is the perfect form of *Uredo Vincetoxici*.

BIBL. Tulasne, *Ann. Sc. Nat.* 4 sér. ii. 188.

CROUA'NIA, J. Agardh.—A genus of Cryptonemiaceæ (Florideous Algæ). *C. attenuata* is a very rare plant, which has been found epiphytic on *Cladostephus spongiosus*. Its frond consists of a single-tubed jointed filament, with the joints clothed with dense whorls of minute dichotomously multiplied branchlets, somewhat beaded. The favellidia are stated to occur near the tips of the branchlets; the tetraspores (large) are affixed to the bases of the latter.

BIBL. Harvey, *Mar. Alg.* pl. 21 D; *Phyc. Brit.* pl. 106; J. Agardh, *Alg. Medit.* 83; Agardh, *Sp. Alg.* ii. 136 (as *Griffithsia nodulosa*); Kützing, *Sp. Alg.* 651 (*Callithamnion*).

CRUCIB'ULUM, Tulasne.—A genus of Nidulariacei (Gasteromycetous Fungi).

C. vulgare occurs frequently on ferns, decayed sticks, &c., and is found in many parts of the world.

BIBL. Sachs, *Bot. Zeit.* xiii. 833; Tulasne, *Ann. Sc. N.* 1844.

CRUCILOCULI'NA, D'Orb.—A Triloculine *Miliola* with a crucial fissure for its aperture—that is, having four small symmetrical valves, instead of one. Known only from the Patagonian coast.

BIBL. D'Orb. *For. Amér. Mér.* 1839; Carpenter, *Introd. For.* 80.

CRUME'NULA, Duj.—A genus of Infusoria, of the family Thecamonadina.

Char. Oval, depressed, with a resisting obliquely striated or reticulated tegument, from a notch in the fore part of which a long flagelliform filament issues; a red eye-spot. Movement slow..

C. testa (Pl. 30. fig. 34). Green; aquatic; length 1-510″. Filament three times as long as the body.

Dujardin appends *Prorocentrum*, E., to this genus.

BIBL. Dujardin, *Infus.* p. 339.

CRUOR'IA, Fries.—A genus of Cryptonemiaceæ (Florideous Algæ). *C. pellita* is common on exposed rocks and stones between tide-marks, forming a glossy purplish skin, between gelatinous and leathery, upon smooth surfaces, in patches 2 to 3″ in diameter. This 'skin' is formed of vertical tufts of simple articulated filaments imbedded in a gelatinous matrix. One of the cells of each filament is larger than the rest. The tetraspores occur at the bases of the filaments.

BIBL. Harvey, *Mar. Alg.* pl. 20 C; *Phyc. Brit.* pl. 117.

CRUSTA'CEA.—A class of Animals, belonging to the subkingdom Articulata.

Char. Apterous; no tracheæ; respiration aquatic (branchial), or effected by the skin: legs jointed. A dorsal vessel, ventricle, or heart; integument composed partly of chitine.

The *integument* of the Crustacea usually forms a hard calcareous shell, sometimes, however, being leathery or horny; it constitutes an external skeleton. In its most complex condition four layers are distinguishable:—an outermost, very thin, transparent, and structureless or cellular—the epidermis; beneath this, a layer of pigment-cells to which the colour is owing, but sometimes the pigment is not contained within cells; under this is a thick layer, forming the greater part of the substance of the integument, impregnated with calcareous salts, and frequently furnished with direct prolongations in the form of tubercles, spinous appendages, or hairs. See SHELL. The innermost layer consists of a delicate fibrous coat, corresponding to an internal periosteum or true skin; it plays an important part in the moulting process (*ecdysis*) which the Crustacea undergo, probably secreting the new layers of the integument.

The higher Crustacea (the Decapoda) have mostly two pairs of antennæ.

The oral organs consist of a transverse labrum or upper lip; beneath which is a pair of powerful toothed mandibles, acting laterally, and furnished with palpi. Next come two pairs of maxillæ; the first are membranous and hairy at the margin, but without palpi; the second are also membranous and hairy, and correspond to the labium of Insects. Between the mandibles and the first pair of maxillæ is sometimes situated a soft, tongue-like, sometimes cleft appendage. The oral organs undergo various modifications in the lower Crustacea; these will be considered under the respective heads. Behind these are three pairs of secondary or auxiliary jaws, or rather legs converted into jaws, and comparable to the six legs of Insects; these are furnished externally with

palpi. Next follow five pairs of true thoracic legs, behind which are five pairs of false or abdominal legs.

The voluntary *muscles* of the Crustacea are transversely striated.

The *eyes* are either simple: consisting of a convex cornea, behind which is a rounded refracting body or lens; this lies in a cup-shaped mass of pigment, perforated by the optic nerves;—compound without facets: consisting of a smooth cornea, behind which a number of closely-placed eyes are situated; sometimes a modification of this form occurs, in the existence of a smooth outer and an inner faceted cornea;—or compound faceted: as in the eyes of insects. The facets are frequently four-sided, but sometimes six-sided. In some of the eyes a conical vitreous body is situated behind the lens. The eyes are sometimes sessile, at others stalked.

The *alimentary canal* is usually short and nearly straight, sometimes curved or coiled. Its wall consists of three or four layers,—the outermost, more or less fibrous, representing a peritoneal coat; the innermost, a transparent, structureless, epithelial coat, furnished at the part corresponding to the stomach with calcareous teeth, scales, or hairs, and which is thrown off during the ecdysis. Between these two coats is a layer of smooth muscular fibres.

The *liver* exists either in the form of simple follicles surrounding the alimentary canal; of branched cæca situated at its upper end, sometimes with short ducts; or as two glandular tufts or branches, consisting of more or less ramified and closely-connected cæca, with short ducts.

In many of the Crustacea the walls of the alimentary canal are surrounded by cells containing a bright orange-yellow or blue fatty matter; these are either scattered or arranged in the form of lobules. They correspond to the fatty body of Insects.

The Crustacea undergo remarkable metamorphoses, the larvæ differing strikingly from the adults; and to these, special names were applied, being considered as distinct genera: as *Nauplius*, *Zoëa*, and *Megalopa*.

See ASELLUS, CIRRIPEDIA, ENTOMOSTRACA, GAMMARUS, ONISCUS, and SIPHONOSTOMA.

BIBL. That of ANIMAL KINGDOM, and the Bibl. of the articles just cited; Gegenbaur, *Vergl. Anat.* 247; Schultze (*eyes*), *Qu. Mic. Jn.* 1868, 173; Chatin, *Compt. Rend.* 1876, lxxxiii. 1052 (*M. M. Jn.* xvii. 92); Bell, *Stalk-eyed Brit.* (figs.); Bate and Westwood, *Sessile-eyed.*

CRYPHÆ'A, Mohr. = PILOTRICHUM.

CRYPTOCOC'CEÆ.—One of Kützing's families of Algæ, including his genera *Cryptococcus*, *Ulvina*, and *Sphærotilus*, all of which appear to be forms of the mycelia (conidia?) of Mildew Fungi; they consist of masses of extremely minute colourless globules, aggregated into a membranous or mucous stratum, and found floating in aromatic waters, vinegar, &c.

CRYPTOCOC'CUS, Kutz. See CRYPTOCOCCEÆ.

CRYPTOGA'MIA.—This term was applied by Linnæus to his 24th Class, which included all plants in which no true flowers exist; the name signifying that the sexual organs are hidden. In Natural Arrangements of the Vegetable Kingdom the term is often used in the same sense; but in this case as one of two great divisions, being opposed to Phanerogamia or Phænogamia, which are plants with the sexual organs conspicuous. See VEGETABLE KINGDOM.

CRYPTOGLE'NA, Ehr.—A genus of flagellate Infusoria, of the family Cryptomonadina.

Char. Free; a red eye-spot; carapace a scutellum, rolled in at the margins, without a neck. Freshwater.

C. conica (Pl. 30. fig. 35 *a*). Conical, expanded, and truncate in front, posteriorly subacute; bluish green; length 1-1150″; two flagelliform filaments.

C. pigra (Pl. 30. fig. 35 *b*). Ovato-subglobose, emarginate in front; green; length 1-1150″. (*Chloromonas*, Kent.) Motion slow; filament single.

C. cærulescens. Elliptic, depressed, emarginate in front; bluish green; length 1-6000″; motion rapid; no cilia distinguished.

Carter adds 3 species.

BIBL. Ehr. *Infus.* 46; Duj. *Infus.* 333; Carter, *Ann. N. H.* 1858, ii. 253; 1859, iii. 18; Pritchard, *Infus.* 509; Kent, *Inf.* 419.

CRYPTOGRAM'MA, Brown.—A genus of Pterideæ (Polypodiaceous Ferns).

Char. Sterile and fertile fronds usually different; sori terminal on the veins, at first separate and rounded, then confluent; indusium formed of the involute margin of the frond.

C. crispa. British.

BIBL. Hooker, *Syn. Fil.* 144.

CRYPTOMONADI'NA, Ehr.—A family of Infusoria.

Char. An envelope or carapace, either

soft or hard; no appendages (organs of motion, D.) except anterior cilia, or one or more flagelliform filaments; form constant. (Envelope insoluble in potash?)

These organisms do not admit colouring-matters, hence they should probably be referred to the Algæ. One or more cilia or flagelliform filaments have been detected in all the genera but one (*Lagenella*).

The family corresponds very nearly with the Thecamonadina of Dujardin.

No eye-spot.
Carapace with a distinct tooth in front — *Prorocentrum*.
Carapace without a tooth — *Cryptomonas*.
Eye-spot present.
Carapace with a neck — *Lagenella*.
Carapace without a neck:—
Carapace a scutellum — *Cryptoglena*.
Carapace not a scutellum — *Trachelomonas*.

Dujardin adds the genera *Phacus*, D. (including *Euglena*, E. in part), *Crumenula*, D., *Diselmis*, D., *Clamidomonas*, E., *Plœotia*, D., *Anisonema*, D. (including *Bodo grandis*, E., and *Oxyrrhis*, D.=*Prorocentrum* E.); and appends doubtfully *Chætoglena*, E., and *Chætotyphla*, E.

See THECAMONADINA, OPHIDOMONAS, and PROTOCOCCUS.

BIBL. Ehrenb. *Infus.* 38; Duj. *Infus.* 323.

CRYPTOMONAS, E.—A genus of Infusoria, of the family Cryptomonadina.

Char. No eye-spot; carapace without an anterior tooth. Dujardin says: Globular or slightly depressed; secreting a membranous flexible carapace, and furnished with a very delicate flagelliform filament.

Ehrenberg admits seven species; and to these Dujardin adds two.

C. ovata, E. (Pl. 30. fig. 36 *a*); length 1-570″; freshwater.

C. lenticularis, E. (Pl. 30. fig. 36 *b*); length 1-1730″; freshwater.

C. fusca, E. (Pl. 30. fig. 36 *c*); length 1-1500″; freshwater.

C. globulus, D. (Pl. 30. fig. 36 *d*); length 1-2500″; freshwater.

C. inæqualis, D. (Pl. 30. fig. 36 *e*); length 1-2500″; freshwater.

Dujardin appends *Cryptoglena*, E., and *Lagenella*, E., to this genus.

BIBL. Ehr. *Inf.* 40; Dujardin, *Inf.* 329; Kent, *Inf.* 404.

CRYPTONEMIA'CEÆ.—A family of Florideæ. Purplish or rose-red sea-weeds, with a filiform or (rarely) expanded, gelatinous or cartilaginous frond, composed wholly or in part of cylindrical cells connected together into filaments. Axis formed of vertical, periphery of horizontal radiating filaments. FRUCTIFICATION:—1. *Conceptacles* (*favellidia*), forming globose masses of spores immersed in the frond or in swellings of the branches. 2. *Tetraspores* variously dispersed. 3. *Antheridia* (*Nemaleon*).

Subtribe 1. COCCOCARPEÆ. *Frond solid, dense, cartilaginous or horny. Favellidia contained in semi-external tubercles or swellings of the frond.*

Grateloupia. *Frond* pinnate, flat, narrow, membranaceo-cartilaginous, of very dense texture. *Favellidia* immersed in the branches, communicating with the surface by a pore. *Tetraspores* scattered.

Gelidium. Frond pinnate, compressed, narrow, horny, of very dense structure. *Favellidia* immersed in swollen ramuli. *Tetraspores* forming subdefined sori in the ramuli.

Gigartina. *Frond* cartilaginous, cylindrical or compressed; its flesh composed of anastomosing filaments, lying apart in firm gelatine. *Favellidia* contained within external tubercles. *Tetraspores* massed together in dense sori, sunk in the frond.

Subtribe 2. SPONGIOCARPEÆ. *Frond solid, dense, cartilaginous or horny. Favellidia of several, imperfectly known. Wart-like swellings composed of filaments; sometimes containing tetraspores, sometimes spores.*

Chondrus. *Frond* fan-shaped, dichotomously cleft, cartilaginous, of very dense texture. *Tetraspores* collected into sori, immersed in the substance of the frond.

Phyllophora. *Frond* stalked, rigid, membranaceous, proliferous from the disk, of very dense structure. *Tetraspores* in distinct superficial sori, or in special leaflet-like lobes.

Peyssonelia. *Frond* depressed, expanded, rooting by the under surface, concentrically zoned, membranous or leathery. *Tetraspores* contained in superficial warts.

Gymnogongrus. *Frond* filiform, dichotomus, horny, of very dense structure. *Tetraspores* strung together, contained in superficial wart-like sori.

Polyides. *Root* scutate. *Frond* cylindrical, dichotomous, cartilaginous. *Favellæ* contained in spongy external warts. *Tetraspores* scattered through the peripheric stratum of the frond, cruciate.

Furcellaria. *Root* branching. *Frond* cylindrical, dichotomous, cartilaginous. *Favellæ* unknown. *Tetraspores* deeply imbedded among the filaments of the periphery, in the swollen pod-like upper branches of the frond, transversely zoned.

Subtribe 3. GASTROCARPEÆ. *Frond gelatinously membranaceous or fleshy, often of lax structure internally. Favellidia immersed in the central substance of the frond, very numerous.*

Dumontia. *Frond* cylindrical, tubular, membranaceous. Tufts of *spores* attached to the wall of the tube inside.

Halymenia. *Frond* compressed or flat, gelatinoso-membranaceous, the membranous surfaces separated by a few slender anastomosing filaments. Masses of *spores* attached to the inner face of the membranous wall.

Ginannia. *Frond* cylindrical, dichotomous, traversed by a fibrous axis; the wall membranaceous. Masses of *spores* attached to the inner face of the membranous wall.

Kallymenia. *Frond* expanded, leaf-like, fleshy-membranous, solid, of dense structure. *Favellidia* like pimples, half immersed in the frond, and scattered over its surface.

Iridæa. *Frond* expanded, leaf-like, thick, fleshy-leathery, solid, of dense structure. *Favellidia* wholly immersed, densely crowded.

Catenella. *Frond* filiform, branched, constricted at intervals into oblong articulations; the tube filled with lax filaments.

Subtribe 4. GLOIOCLADIEÆ. *Frond loosely gelatinous; the filaments lying apart from one another, surrounded by a copious gelatine. Favellidia immersed among the filaments of the periphery.*

Cruoria. *Frond* crustaceous, skin-like.

Naccaria. *Frond* filiform, solid, cellular; the ramuli only composed of radiating free filaments.

Gloiosiphonia. *Frond* tubular, hollow; walls of the tube composed of radiating filaments.

Nemaleon. *Fronds* filiform, solid, elastic, filamentous; the axis composed of closely-packed filaments; the periphery of moniliform free filaments.

Dudresnaia. *Frond* filiform, solid, gelatinous, filamentous; the axis composed of a network of anastomosing filaments; the periphery of moniliform free filaments.

Crouania. *Frond* filiform, consisting of a jointed filament, whorled at the joints, with minute, multifid, gelatinous ramuli.

BIBL. Harvey, *Marine Algæ*; Derbès et Solier, *Ann. Sc. Nat.* 3 sér. xiv. 273. See also the Genera.

CRYPTOSTIPHUM, Buckt.—A genus of Aphidæ.

Char. Cornicles none or mere pores; cauda small; antennæ with 7th joint short.

C. Artemisiæ. Brown or blackish, very mealy; eyes reddish. On *Artemisia vulgaris*, deforming and colouring the leaves.

BIBL. Buckton, *Aphides*, ii. 145.

CRYPTOSPO'RIUM, Kze.—A genus of Sphæronemei (Stylosporous Fungi). Microscopic Fungi growing upon bark and leaves, producing spindle-shaped spores, at first conglutinated beneath the epidermis of the nurse-plant. Two species have been recorded as British.

C. Caricis, Corda. Heaps of spores punctiform; spores slightly curved, dark brown and pellucid. On leaves of various sedges. Corda, *apud* Sturm, *Deutschl. Flor.* t. 1.

C. vulgare, Fries. Heaps confluent; spores curved, black (subhyaline). On dead twigs of birch, hazel, alder, &c. Corda, *l. c.* t. li.

BIBL. Berkeley and Broome, *Ann. N. H.* 2 ser. v. 371; Fries, *Syst. Myc.* iii. 481.

CRYPTOSTE'GIA, Reuss.—A group of hyaline Foraminifera, having an Agathistegian or Milioline mode of growth, comprising *Chilostomella* and *Allomorphina*, Reuss, and probably *Ellipsoidina*, Brady. These are near allies of *Sphæroidina*, and thereby related to *Pullenia* and *Globigerina*. *Chilostomella* has successive chambers, almost entirely overlapping one another, as in *Biloculina*, but with a hyaline, and not a porcellaneous shell. *Allomorphina* is triloculine.

Recognized in Cretaceous and Tertiary strata, and in existing oceans.

BIBL. Reuss, *Sitzungs. Akad. Wien*, 1861, xliv. 372; Brady, *Qu. Mic. Jn.* xix. 66.

CRYSTALLINE LENS. See EYE.

CRYSTALLOG'RAPHY.—The laws of crystallography teach us that in perfectly formed crystals, each peculiar chemical combination corresponds to a distinct relation of all the angles which can possibly arise from the primary form; hence by ascertaining the latter, we can usually infer the former. It was our intention to have given a sketch of the method of determining the primary forms of the more common microscopic crystals, and the systems to which they belong; but our space is far too limited for this purpose, and the subject is so difficult, that we must rest satisfied with a re-

ference to works specially devoted to the subject.

Bibl. Schmidt, *Entw. ein. allg. Untersuch. &c.*; Robin and Verdeil, *Chimie Anatom. &c.*; Phillips, *Intr. to Mineral.* (Brooke and Miller); Dana, *Mineral.*; Naumann, *Elem. d. Min.*; Nicol, *Man. of Miner.*; Rammelsberg, *Krystallkunde*; Nägeli & Schwendener, *Mikr.* 478.

CRYSTALLOIDS.—These bodies have been noticed under Chalk and Coccoliths.

The term has been more recently extended to certain bodies formed of the protoplasmic contents of vegetable cells, which assume crystalline forms, and exhibit the facets and polarizing properties of crystals, yet possess resemblances to organic cell-structures. They are usually colourless, sometimes coloured, the colouring matter being removeable. They swell with reagents, and consist of two substances of different solubility. They are found in the cell-nuclei of *Lathrea*, the cells of the skin of the potato, in seeds, and in aleurone-grains (page 28, fig. 6 *b*).

So that we now have 3 kinds of crystalloids: Ehrenberg's chalk- and concretionary crystalloids; the vegetable crystalloids; and Graham's (dialytic) crystalloids = true crystalline matter.

Bibl. Hartig, *Bot. Zeit.* 1856, 262; Badlkofer, *Kryst. prot.* 1859; Nägeli, *Bay. Ak.* 1862, 233; Sachs, *Bot.* 50; Rodwell, *Dict. Sc.* 162.

CRYSTALS.—Crystals are constantly met with in the examination of animal and vegetable products; and the determination of their nature or composition is often of great importance.

There are five methods of ascertaining this: 1, by ascertaining the atomic weight of the substance, or by its quantitative analysis; 2, by the study of its crystallographic properties; 3, by its qualitative analysis; 4, by its spectroscopic analysis; 5, by its polariscopic analysis.

The first belongs to the domain of chemistry, and requires an appreciable quantity of substance.

The second requires well-formed crystals, and a knowledge of crystallography. As the latter is an exceedingly difficult science, recourse is generally had to the third method, upon which some remarks have already been made in the Introduction, p. xlii; the fourth is indispensable in many cases, but requires expensive apparatus and great practice; the fifth is only partially applicable.

The forms of crystals vary according to the conditions under which they are produced; but there can be no doubt that, under absolutely the same conditions, their forms would be relatively constant. In many animal and other liquids, the forms assumed by the crystals deposited are tolerably characteristic, so that their composition may be inferred; but where accuracy is required, it is always well to use chemical reagents. See Raphides.

The cavities in topaz and other mineral crystals were shown years ago by Brewster to enclose a liquid, crystals, or even a vacuum. This subject has been further investigated by Sorby and Rutley in rocks, stones, lava, &c., and important geological conclusions have been deduced therefrom. Attention has also been drawn to the cavities containing air or vapour in artificial crystals, and to the crystals formed in blow-pipe beads.

Crystals, when rapidly formed, constitute beautiful microscopic objects; the arborescent, radiating and other appearances which they present are well known; and a more exquisitely curious and interesting sight cannot be witnessed than the very formation itself taking place under the the microscope. This may be readily seen in a drop of any saline solution spontaneously evaporating upon a slide. See Uric acid and Polarization; and for crystals in plants, Raphides.

Bibl. Sorby, *Geol. Jn.* xviii.; id. (*blow-pipe beads*) *Mn. Mic. Jn.* i. 349; and *Jn. Mic. Soc.* 1878, i. 1; Guy, *Mic. Trans.* 1868, 1; Davies-Matthews, *Mounting*, 111; also Chemistry, Crystallography, and Rocks.

CTENOSTO'MATA.—A suborder of Infundibulate Polyzoa (Bryozoa). Distinguished by a fringe of bristles (more or less developed) when the animal is protruded. Families:

Alcyonidiidæ. Polypary sponge-like, fleshy, irregular in shape; cells immersed, with a contractile orifice.

Vesicularïidæ. Polypary plant-like, horny, tubular; cells free, deciduous, the ends flexible and invertible.

Pedicellinidæ. Polypary plant-like, creeping, adherent, sending up at irregular intervals free, erect, stalked bodies, without distinct cells.

Flustrellidæ. Cells immersed in a gelatinous crust, orifice bilabiate.

Arachniidæ. Cells more or less distant, membranous.

Buskiidæ. Cells contracted below, not continuous with the creeping stolon; with a ventral aperture.

Cylindrœcidæ. Cells not contracted below, closely united to the stem; no membranous area.

Triticellidæ. Cells horny, with an aperture, and a ventral membranous area; attached to a rigid peduncle by a moveable joint, deciduous.

Victorellidæ. Cells originating in an enlargement of the creeping tubular stem, with which they are continuous at the base; free and cylindrical above, not deciduous.

Bibl. Johnston, *Br. Zooph.*; Gosse, *Mar. Zool.* ii.; Hincks, *Polyz.* 489.

CUCULLA'NUS, Müll.—A genus of Entozoa, belonging to the order Cœlelmintha, and family Nematoidea.

Char. Body elongate, posteriorly attenuate; head broad, with a bivalve manducatory apparatus; mouth anterior, terminal, forming a long vertical fissure.

C. elegans. In the intestine, stomach, and pyloric appendages of the perch and other freshwater fishes. Almost all the other species of this genus live in the intestines of fishes. Length 1-6 to 1-3″. Colour, reddish yellow.

C. foveolatus, in the plaice.

Bibl. Dujardin, *Helminthes*, 245; Cobbold, *Paras.* 474.

CUCURBITA'RIA, Grev. See Sphæria.

CU'LEX, Linn.—A genus of Dipterous Insects, of the family Culicidæ.

Char. Palpi longer than the proboscis in the male, very short in the female.

Many species. *C. pipiens*, the common gnat. See Culicidæ

CULIC'IDÆ.—A family of Dipterous Insects, as the type of which the common gnat (*Culex pipiens*) may be examined.

The parts of the mouth are produced into a slender elongated rostrum or proboscis, which is nearly half the entire length of the insect, and slightly thickened at the tip. This proboscis, simple as it appears, in reality consists of seven pieces in the females, besides a pair of many-jointed palpi, which are as long as, or even longer than, the rostrum in some of the males, and very hairy at the extremity; in the females, however, they are generally very short. Head small. Antennæ slender and filiform, as long as, or longer than the thorax, and 14-jointed in both sexes, but plumose in the male (Pl. 33. fig. 21) and pilose in the females (Pl. 33. fig. 30 *a*); the basal joint is subglobose and tubercular in form. Eyes lunate; ocelli obsolete. Thorax oblong-oval. Abdomen long and slender, upon which the wings are incumbent when at rest; the latter have the veins furnished with scales (Pl. 34. fig. 22). Legs very long and slender.

The proboscis of the female is composed of the following parts:—1. An outer tubular canal (Pl. 33. figs. 30 & 31 *e*), representing the labrum, forming the most robust part of the mouth, except the labium. 2. A pair of slender, needle-like pieces, the mandibles, serrated on the inside near the tip (Pl. 33. figs. 30 & 31 *f*), thickened at the back, like a scythe, and transversely striated. 3. A second pair of very delicate and slender organs (Pl. 33. figs. 30 & 31 *g*), dilated at the base, to which the palpi are attached, representing the maxillæ. 4. A slender, needle-like instrument, lanceolate at the end, traversed by a narrow canal (Pl. 33. figs. 30 & 31 *d*), the analogue of the tongue. 5. The outer tubular canal (Pl. 33. fig. 30 *i*), in which the others are lodged when at rest, and representing the labium. The labrum and labium are each traversed by a longitudinal slit throughout their length.

It appears that in the males the labrum and tongue are absent. It has been supposed that, when the lancets of the female gnat are introduced into the skin, a venomous liquid is simultaneously instilled into the wound, and that the great irritation produced may thus be accounted for. It is more probable, however, that this arises from the deeper penetration of the lancets into the skin; for they are of great comparative length—about four times that of the lancets of the flea.

The eggs are deposited in a small boat-shaped mass which floats upon the surface of the water. They are oval, with a small narrow knot at the top, and are arranged side by side, and closely packed.

The larvæ inhabit standing waters, and may be observed frequently, during the spring and summer, jerking themselves about with great agility, or suspending themselves, for the purpose of respiration, immediately below the surface of the water, with the head downwards. The head (Pl. 35. fig. 1) is distinct, large, rounded, and furnished with two unjointed antennæ, and several ciliated appendages, which serve for

obtaining nourishment. The thorax is furnished with bundles of feathery hairs; the abdomen is long, nearly cylindrical, much narrower than the front parts of the body, and divided into ten segments, the eighth of which is furnished with a long respiratory air-tube, terminated by a small star; the last joint is terminated by setæ, and by five conical slender plates.

After several moultings, the larvæ are transformed into pupæ, which also move about with agility by means of the tail and two terminal swimming organs. In this state they take no food; and the position in which they suspend themselves in the water is the reverse of that previously assumed, *i. e.* the head is upwards. The respiratory organs consist of two air-tubes placed upon the thorax; and the body is much curved. The final transformation takes place in three or four weeks, the exuviæ of the pupa serving as a raft, upon which the insect remains until its wings are extended.

Bibl. Westwood, *Introd.* 507; Robineau Desvoidy, *Mém. Soc. d'Hist. N.* iii. 1827, 390; Stephens, *Zool. Jn.* i.; Curtis, *Brit. Entom.* xii. 537; Macquardt, *Dipt.* (*Suites à Buff.*); Walker, *Insect. Brit., Dipt.* iii. 242.

CULTIVATION or CULTURE.—This term has recently been used in a specific sense, to signify the growth of the Schizomycetes, such as *Bacterium*, *Bacillus*, &c., in artificial liquids. It has been observed, that when these organisms reproduce themselves in organized bodies, the reproduction takes place by simple vegetative division. But when grown in the artificial soils, with free exposure to air, they produce new forms and give rise to spores. At the same time, in the case of those *Bacteria* &c. which are the origin of specific diseases, their virulence is found to be destroyed; and on inoculation, instead of the original virulent disease being produced, a mild form of the same, which exerts a protective influence, is the result.

Several cultivation-liquids have been used, among which the following may be mentioned. Pasteur's liquid, composed of phosphate of potash 2 pts., phosphate of lime ·2, sulphate of magnesia ·2, tartrate of ammonia 10, sugar-candy 150, and water 857 pts.; or tartrate of ammonia 1 pt., yeast-ash 1, distilled water 100 pts. Cohn's liquid consists of 1 pt. phosphate of potash, 1 sulphate of magnesia, 2 tartrate of ammonia, and ·1 of chloride of calcium in 200 pts. of distilled water. These liquids should be thoroughly sterilized by boiling before use, and should be kept in stoppered bottles. More recently, the cut surface of a potato, or beetroot, has been used as a cultivation-bed; also a layer of gelatine so saturated with water as just to solidify on cooling. In these experiments, it has been found that there is no transition of forms, at least among the pathogenous Schizomycetes; a *micrococcus* producing *micrococci*, a *bacillus* *bacilli*, and a *spirillum* *spirillia* only.

Bibl. See Schizomycetes; Maddox, *M. M. Jn.* 1870, iii. 14; Koch, *Qu. Mic. Jn.* xvii. 87, and xxi. 650; Lister, *ibid.* xviii. 191; Klebs, *Rep. Intern. Med. Cong., Times*, Aug. 8, 1881; Pasteur, *ibid.* Aug. 9, 1881.

CUNEOLINA, D'Orb.—A Textularian Foraminifer, extremely compressed transversely to the usual direction of the compression in *Textularia*.

Rare in the Lower Cretaceous formation.

Bibl. D'Orbigny, *For. Foss. Vien.* 1846; Carpenter, *Introd. For.* 193.

CUPRESSIN'EÆ.—A suborder of Coniferæ (Gymnospermous Flowering Plants), distinguished from the Abietineæ by the erect ovules and spheroidal pollen-grains. Further particulars will be found under Coniferæ and Wood.

CURCU'LIO, Linn.—A genus of Coleopterous Insects of the family Curculionidæ (weevils).

Curculio imperialis, the diamond-beetle, is well known on account of the splendid colours which its elytra exhibit. Many other members of this family present colours almost equally brilliant. These colours are produced mainly by the action of minute scales upon the incident light. See Scales of Insects.

The oral organs of the Curculionidæ are curiously placed at the end of an elongated rostrum which represents the head, and to the sides of which the antennæ are attached.

Bibl. Westwood, *Introd.*; Stephens, *British Beetles*.

CURCU'MA, L.—A genus of Zingiberaceæ (Monocotyledons), remarkable on account of the tuberous rhizomes. Those of *C. longa* form the substance called turmeric; and the starch from the cells of the young tubers forms one of the kinds of East-Indian arrowroot. The tubers of other species yield very pure starch, and furnish East-

Indian arrowroots. The grains of an unknown *Curcuma* imported under that name are represented in fig. 19 of Plate 46.

CUS'CUTA, Tournefort.—A curious genus of Convolvulaceæ (Dicotyledons), consisting of parasitical, leafless plants, annual or perennial, nourished by short radical processes, which they usually send into the interior of the stems of the plants upon which they live, although they sometimes affix themselves to leaves also (*C. Epithymum*). *C. Epilinum*, which grows in cultivated fields of flax, and *C. Trifolii*, parasitical on clover, twine round the stems like a fine red string, and produce root-processes in rows on the side next the nurse-plant, never on the free side. Careful sections show that the woody structure of the roots of the parasite penetrates the cambium (or even the pith) of the nurse-plant, and becomes completely grafted on it. In the perennial kinds (*C. verrucosa*), the roots become imbedded in the annual rings. The embryo of *Cuscuta* is curious, being filiform, and coiled up like a watch-spring in the seed.

Bibl. Wheeler, *Phytologist*, i. 753; Brandt, *Linnæa*, xxii. 81; Schacht, *Beit. z. An. und Phys.* 1854, 167; Uloth, *Flora*, 1860, 265.

CUSPIDEL'LA, Hincks.—A genus of Hydroid Polypi; family Lafoëidæ.

C. humilis. Wales, Shetland, Northumberland.

Bibl. Hincks, *Brit. Zooph.* 209.

CUTICLE of Animals. See Skin.

CUTICLE of Plants. See Epidermis.

CUTLE'RIA.—A genus of Cutleriaceæ (Fucoid Algæ), represented in Britain by *C. multifida*, which has a "rooting," fan-shaped, irregularly laciniated frond from 2 to 8" long, the laciniæ riband-like, between cartilaginous and membranous, olive, with scattered sori, bearing on some plants (which have an orange tint) *antheridia*, and on others *oosporanges* (fig. 148).

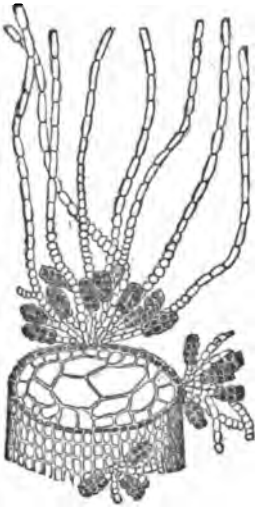
Fig. 148.

Cutleria dichotoma. Fragment of a frond. Nat. size.

The oosporanges (fig. 148) occur at the bases of tufted hairs, and are oblong stalked bodies, divided by perpendicular and transverse septa into (usually) 8 chambers, each of which gives birth to a zoospore capable of germination. The *antheridia* occur in an analogous condition on distinct plants; they are more sausage-shaped, and divided into a greater number of minute chambers, from which the spermatozoids or antherozoids are expelled when mature; these have never been seen to germinate.

Bibl. Harvey, *Mar. Alg.* 36, pl. 6. A; *Phyc. Brit.* pl. 75; Greville, *Brit. Alg.* pl. 10; Thuret, *Ann. Sc. Nat.* 3 sér. xiv. 241, pl. 31, xvi. 12, pl. 1; Kützing, *Phyc. gen.* pl. 25. fig. 2.

Fig. 149.



Cutleria dichotoma.

Section of a lacinia of a frond, showing the stalked eight-chambered oosporanges growing in tufts with intercalated hairs. Magnified 50 diameters.

CUTLERIA'CEÆ.—A family of Fucoid Algæ. See Cutleria.

CUTTLE-FISH. See Sepia.

CYATHE'Æ.—A family of Polypodiaceous Ferns, distinguished by the dorsal globose sori, often at or near the forking of a vein, and the insertion of the sporanges on a projecting axis, the annulus of the sporanges being vertical (fig. 151); indusium (except in *Alsophila*) enclosing the sori.

Tropical or subtropical, mostly arborescent.

Genera.

Cyathea. Sori hemispherical, regularly arranged. Indusium at first closed, at length bursting in a circumscissile manner, and cup-shaped.

Alsophila. Sori globose, regularly arranged. Sporanges inserted on a globose axis, and imbricated.

Hemitelia. Sori globose, each solitary on a venule. Indusium an ovate, concave, torn scale, situated at the lower side of the base.

Cnemidaria.

Dicalpe. Receptacle small, scarcely elevated. Indusium hard-membranaceous, entire, finally bursting irregularly at the summit; capsules numerous, nearly sessile, annulus broad.

Matonia. Receptacle expanded into a firm and membranaceous umbrella-shaped obscurely 6-lobed indusium, enclosing 6 large sessile capsules.

Thyrsopteris.

CYA'THEA, Smith.—A genus of Cyatheæ (Polypodiaceous Ferns), most of which are tropical. They have a cup-like indusium, whence the name. Arborescent. (Figs. 150, 151.) 55 species.

Fig. 150.

Fig. 151.

Cyathea elegans.

Fig. 150. Pinnule with sori. Magnified 5 diameters.
Fig. 151. Vertical section of a sorus in a cup-like indusium. Magnified 25 diameters.

BIBL. Hooker and Baker, *Syn. Fil.* 16.

CYATHO'MONAS, From. = *Monas* truncate or excavate in front.

8 species; freshwater; length 1-3000 to 1-1000". *C. spissa* (Pl. 58. fig. 17).

BIBL. Fromentel, *Microzoaires*; Kent, *Infus.* 141.

CY'ATHUS, Hall.—See NIDULARIACEI.

CYCADA'CEÆ.—A family of Gymnospermous Flowering Plants. The microscopic structure of the wood is analogous to that of the Conifers; and the mode of fertilization of the ovules is similar. (See GYMNOSPERMIA.) Species of *Cycas*, *Zamia*, &c. are commonly cultivated in botanical gardens. They offer interesting subjects of microscopic investigation. The parenchymatous tissue, in the form of pith, large medullary rays, and in *Cycas* of concentric rings alternating with those of the wood, is remarkable for the quantity of starch contained in it at certain periods. This is extracted and used as arrowroot or sago. *Cycas circinalis* furnishes a kind of sago (its starch-grains are represented in Pl. 46. fig. 17). *Dion edule* yields a kind of arrowroot in Mexico. *Encephalartos* yields Caffre-bread at the Cape, &c. The wood is composed, in *Cycas* and *Zamia*, almost wholly of large dotted tubes, somewhat like those of *Araucaria* (with many rows of bordered pits) (Pl. 48. fig. 20); but a medullary sheath exists, composed of unrollable spiral vessels, with tubes of varied character, reticulate, annular or other fibrous forms, as in the Dicotyledons; and in *Zamia* the dotted tubes are said to be unrollable in some cases into spiral ribands. In *Zamia* and *Encephalartos* there does not appear to be a distinction of concentric rings of wood; but in *Cycas* these exist, separated by layers of cellular tissue. The rings, however, are not "annual," only five or six existing in large old trunks. The leaves of the Cycadaceæ possess a remarkably solid epidermal structure; and in *Cycas* the upper thickened walls of the epidermal cells exhibit pore-canals or deep pits running from the cavity of the cell towards the outer surface, as well as towards the contiguous cells (Pl. 47. fig. 28). See EPIDERMIS. The pollen of the Cycadaceæ is angular, collected in masses, and transparent; it is contained in anthers of peculiar form seated on the lower surface of the scales of the male cones.

BIBL. Don, *Ann. N. H.* v. 48; *Linn. Trans.* xvii.; Brongniart, *Ann. Sc. Nat.* xvi. 589; Mohl, *Verm. Schrift.* 195; Link, *Icon. Select.* fasc. ii. t. ix. & xv.; Miquel, *Linnæa*, xviii. 125, and pls. 4, 5, 6 (*Ann. Sc. Nat.* 3 sér. v. 11). Also the BIBL. of GYMNOSPERMIA.

CY'CAS, L. See CYCADACEÆ.

CYCLAM'MINA, Brady.—An arenaceous Foraminifer; nautiloid, subglobose, with numerous chambers, labyrinthic within; last chamber opening with a transverse

slit and some large pores. Recent; in deep parts of the Atlantic and Pacific.

Bibl. H. B. Brady, *Qu. Mic. Jn.* xix. p. 43.

CYCLIDI'NA, Ehr.—A family of Infusoria.

Char. No carapace; a single alimentary orifice; appendages in the form of cilia or bristles.

Body with	cilia...	Flattened, cilia forming a circle.....	*Cyclidium.*
		Rounded, cilia scattered	*Pantotrichum.*
	bristles		*Chætomonas.*

Bibl. Ehr. *Infus.* p. 244.

CYCLID'IUM, Hill, Ehr.—A genus of Holotrichous Infusoria.

Char. Body compressed; organs of locomotion a circle of abdominal cilia-like feet; mouth ventral, with a hood-shaped extensile membrane.

C. glaucoma (Pl. 30. fig. 37 *c*, side view; *d*, dorsal view). Oblong-elliptical, entire, with a long saltatory seta in front (behind, Kent); circle of cilia large; dorsal lines very fine; contractile vesicle placed at the front end (back, Kent); freshwater; length 1-2880 to 1-1150″. Cl. & L. include under this species *Acomia ovulum, Alyscum saltans, Enchelys triquetra,* and *Uronema marina.*

C. margaritaceum. Orbicular-elliptic, slightly emarginate posteriorly; cilia obsolete; pearly; freshwater; length 1-2100 to 1-1000″ (this is *Glaucoma margaritaceum,* Clap. & Lachm.).

Two doubtful species,—*C. planum* and *lentiforme.*

C. elongatum, Cl. & L.

Dujardin includes his species of *Cyclidium,* the relation of which to those of Ehrenberg is doubtful, in the family Monadina, with the characters—

Body disk-shaped, depressed or lamelliform, but little variable in form, with a single flagelliform filament. Four species; freshwater.

C. nodulosum. With series of nodules and vacuoles; motion extremely slow; length 1-530″.

C. abscissum (Pl. 30. fig. 37 *b*). Lamelliform, oval, truncated posteriorly; motion slow; length 1-920″.

C. distortum (Pl. 30. fig. 37 *a*). Oval, nodular, irregularly twisted; margin thickened; length 1-1800″.

C. crassum. Length 1-1800 to 1-1100″.

Bibl. Ehr. *Infus.* 245; Duj. *Infus.* 286; Cl. & L. *Inf.* 271; Kent, *Inf.* 544.

CYCLOCHÆ'TA, Jackson.—A genus of Peritrichous Infusoria, allied to *Trichodina.*

C. spongillæ. In the interstices of the freshwater sponge.

Bibl. Jackson, *Qu. Mic. Jn.* 1875; Kent, *Inf.* 650.

CYCLOCLY'PEUS, Carpenter.—A relatively large, discoidal, Nummuline Foraminifer, which grows by concentric *annuli* of chamberlets, instead of spirally with successive chambers. It thus bears the same relation to its ally *Heterostegina* that *Orbitolites* does to *Orbiculina.* Known only recent from Borneo.

Bibl. Carpenter, *Phil. Tr.* 1856; *Foram.* 292.

CYCLOGLE'NA, Ehr.—A genus of Rotatoria, of the family Hydatinæa.

Char. Eyes more than three, forming a cervical group; foot forked.

Pharyngeal jaws with one or perhaps three teeth.

C. lupus (Pl. 43. fig. 18). Body ovate-oblong or conical, not auricled; foot and toes short; aquatic; length 1-144 to 1-120″.

C. ? *elegans.* In Egypt.

Bibl. Ehr. *Infus.* p. 453.

CYCLOGRAM'MA, Perty.—A genus of Infusoria.

C. rubens = a *Nassula,* Cl. & L.

Bibl. Clap. & Lachm. *Infus.* p. 326; Perty, *Lebensf.* p. 146.

CYCLOLI'NA, D'Orb.—An excessively thin discoidal condition of *Patellina,* consisting of perfect *annuli* and very little umbilical cell-growth. In Cretaceous strata, France.

Bibl. D'Orb. *For. Fos. Vien.* 139; Parker and Jones, *Ann. N. H.* ser. 3, vi. 36; Carpenter, *Introd. For.* 230, 233; Carter, *An. N. H.* 1861, Dec., 464.

CYCLOPI'NA, Claus.—A genus of Copepodous Entomostraca.

C. littoralis, gracilis, and *ovalis*; in dredgings.

Bibl. Brady, *Copep.* i. 91.

CY'CLOPS, Müller.—A genus of Copepodous Entomostraca, family Cyclopidæ.

Char. Foot-jaws large and strong, branched; eye single, frontal; inferior antennæ simple; external ovaries two. (Both superior antennæ in the male furnished with the swelling and hinge-joint.)

C. quadricornis (Pl. 20. figs. 8–15). The only species. Variable in colour; freshwater; length 1-17 to 1-14″.

Thorax composed of four, and abdomen (apparently the tail) of six segments; head

consolidated with the first and largest joint of the thorax; last joint of abdomen consisting of two separate lobes.

Superior antennæ (figs. 8, 9 *a*) composed of many joints (twenty-six, Baird), from each of which one or more setæ arise; in the male, each superior antenna exhibits a swelling at about its middle (fig. 8 *b*), followed by a sudden contraction, the first articulation of which forms a hinge-joint; inferior antennæ (fig. 9 *b*) four-jointed, each joint with setæ, the terminal with six of unequal length. The mandibles (fig. 11) consist of an ovate body (*a*), narrowed and twisted above, and terminating in a number of brownish teeth, with a marginal serrated seta (*b*); each mandible has also a palpus, consisting of one segment and two long filaments.

Behind the mandibles, the first pair of foot-jaws (fig. 12) are situated; each consists of a body, convex externally, concave internally, furnished at the end with two or three strong teeth, and with a single-jointed palp-like organ terminated by setæ.

The second pair of foot-jaws (fig. 13 *a b*) are divided to the base into two portions; an internal (*b*) smaller, and consisting of four joints, each with one or more setigerous spines, the last with three; and an external (*a*) composed of three joints, to the base of the first of which the internal portion is attached; this first joint is the longest, and furnished on its inner side with two tubercles, each with one or two setigerous spines, a longer jointed spine arising from near its distal extremity; the second joint is furnished with two strong claws of nearly equal size; and to its upper edge is attached the third joint, smaller than the second, also furnished with two claws; some of the spines are themselves setigerous.

There are five pairs of legs or feet, four of which are branchial, uniform, and arise from the thoracic segments. Each of these legs (fig. 14) is composed of two branches arising from a common base; each branch is three-jointed, and each joint is furnished with elegantly plumose setæ, the last having six or seven. The fifth pair of legs (fig. 15) are rudimentary, and arise from the first and smallest segment of the abdomen; they are two-jointed in the female, and three-jointed in the male.

The external ovary (fig. 9) communicates directly with the internal by means of a small canal on each side between the first and second segments of the abdomen.

The tail consists of two lobes, each terminated by four variously setigerous filaments, the two intermediate being the longest, and jointed near their origin; sometimes there are two joints to each, and the outer ones are also jointed.

Scarcely a pool of water can be found in which this animal may not be seen darting about in various directions. It varies greatly in structure and appearance, according to age, locality, sex, &c.; and these varieties have been admitted as so many species by some authors.

Pl. 20. fig. 16 represents a recently hatched *Cyclops* (*Nauplius*-form).

The individuals are frequently covered with *Vorticellæ* and other parasitic Infusoria.

Bibl. Baird, *Ent.* 198; Koch, *Deutschl. Crustac.*; Claus, *Wieg. Arch.* 1857; *Tr. M. Soc.* 1880, 251; Brady, *Copep.* (*Ray Soc.*).

CYCLO'SIS. See Rotation.

CYCLOSTO'MATA.—A suborder of marine Infundibulate Polyzoa.

Families: Tubuliporidæ, Crisiidæ, Horneridæ, and Lichenoporidæ.

CYCLOTEL'LA, Kütz.—A genus of Diatomaceæ.

Char. Frustules free or adherent, disk-shaped, mostly solitary; valves circular, flat, convex, depressed or undulated, striated; striæ radiating.

The frustules of some of the species are immersed in an amorphous gelatinous substance.

When the valves of (all?) the species of *Cyclotella* are examined under an object-glass of large aperture, with the central stop (Intr. p. xix), the surface is found to be marked with dots in radiating rows, as in some species of *Coscinodiscus*; hence these two genera should probably be united. Some appear to represent the frustules of *Melosira* seen in end view.

C. operculata, K. (*Pyxidicula operculata*, E., *Discoplea Kützingii*, E.) (Pl. 16. fig. 21; *a*, side view; *b*, front view). Angles of frustules in front view rounded; striæ obscure, very short, giving the margin a punctate appearance; freshwater; diameter attaining 1-1000″.

β. rectangula, K. (*C. Kützingiana*, S.) (Pl. 16. fig. 22). Angles of front view not rounded; striæ more distinct.

C. Meneghiniana. Valves plane, distinctly striated at the margin; fr. wat.; length 1-1440″.

β. major. Twice as broad.

C. antiqua, S. (*Discoplea atmospherica*,

E.). Valves convex; striæ broad, reaching neither the centre nor the margin; fr. wat.; diam. 1-760″.

Kützing characterizes three marine species, with the valves free from striæ, and seventeen doubtful species, marine and fossil, belonging to the genera *Actinocyclus*, *Discoplea*, and *Hyalodiscus* of Ehrenberg. Rabenhorst describes 9 species.

Bibl. Kützing, *Syn. Diat. Bacill.* 50, and *Sp. Alg.* 18; Ehrenberg, *Berl. Ber.*, *Infus.*, and *Mikrog.*; Smith, *Brit. Diat.* 27; Thwaites, *Ann. N. H.* 1848, i. 169.

CYCLOT'RICHA, Kent.—A genus of Holotrichous Infusoria.

C. citrea = *Ophryoglena citreum*, Cl. & Lachm.

CY'CLOUM, Hass.—A genus of Infundibulate Ctenostomatous Polyzoa.

Char. Zoary fleshy, incrusting, covered with imperforate papillæ; ova in clusters.

C. papillosum. Tentacles 18; on *Fucus serratus*: referred to *Alcyonidium*.

Bibl. Hassall, *Ann. N. H.* 1841, vii. p. 483; Gosse, *Mar. Zool.* ii. 19 (fig.); Hincks, *Polyz.* 493.

CYLINDROCYS'TIS. See Coccochloris.

CYLINDRŒ'CIDÆ. — A family of Ctenostomatous Polyzoa.

Gen.: *Cylindrœcium* and *Anguinella*.

CYLINDRŒ'CIUM, Hincks.—A genus of Cylindrœcidæ, Ctenostomatous Polyzoa.

Char. Cells elongate, cylindrical, arising from a creeping stolon; no gizzard. 3 species, marine, on rocks, sea-weeds, &c.

Bibl. Hincks, *Polyz.* 535.

CYLINDROLEBE'RIS, Brady.—A genus of Ostracode Entomostraca, fam. Cypridinidæ.

2 recent British species: *C. mariæ* and *C. teres*, both marine.

Bibl. Brady, *Linn. Trans.* xxvi. p. 464.

CYLINDROPSYL'LUS, Brady.—A genus of Copepodous Entomostraca. *C. lævis*, in dredgings.

Bibl. Brady, *Copep.* (*Ray Soc.*), iii. 30.

CYLINDROSPER'MUM, Kützing (*Anabaina*, Bory and others).—A genus of Nostochaceæ (Confervoid Algæ), with the filaments less radiating than in the allied *Sphærozyga*; distinguished under the microscope by the resemblance of the filaments to an annulose animal; the ordinary cells looking like a long jointed body, the large elliptic sporangial cell like a thorax, and the terminal vesicular cell often bearing fine hairs, like a head. British species:

C. catenatum, Ralfs (Pl. 8. fig. 4). Filaments moniliform; ordinary cells orbicular; vesicular cells oval; sporanges oval, catenate. (Ralfs, *Ann. N. H.* 1850, vol. v. pl. 9. fig. 14.) Forming a bluish stratum, containing very delicate, elongated, straight or slightly flexuose, generally parallel filaments.

The remaining British species are not described by Ralfs; but the following are noticed as British by Kützing.

C. macrospermum, Kütz. Filaments thick, equal; ordinary cells oblong, 1-700th of a line in diameter; sporanges oblong, turgid, firm, fuscous, 1-100 to 1-60‴ long, 1-300 to 1-200‴ thick. Kützing, *Sp. Alg.* 293; *Tab. Phyc.* vol. i. pl. 98. fig. 4. *Anabaina impalpebralis*, Hassall, *Algæ*, pl. 75. fig. 3. Standing water; forming an æruginous green stratum.

C. mesoleptum, Kützing. Filaments densely entangled, unequal, 1-800 to 1-850‴ thick; sporanges oblong, 1-180 to 1-150‴ long, 1-350 to 1-300‴ broad, slightly constricted in the middle. Kützing, *Sp. Alg.*; *Tab. Phyc.* vol. i. pl. 98. fig. 5. *Anabaina constricta*, Hassall, *Algæ*, pl. 75. fig. 9. Æruginous green; in brackish marshes.

Excluded species of Kützing:—*C. elongatum* = *Sphærozyga elastica*, Ag. (Ralfs); *C. leptospermum* = *Sphærozyga leptosperma* (Ralfs); *C. Carmichaelii* = *Sphærozyga Carmichaelii* (Harvey); *C. Ralfsii* = *Dolichospermum Ralfsii* (Ralfs); *C. Hassallii* = *Coniophytum Thompsoni* (Hassall).

Rabenhorst describes 13 European species.

Bibl. Ralfs *on Nostochineæ*, *Ann. N. H.* 1850, vol. v. 321; Kützing, *Sp. Alg.*; Rabenhorst, *Fl. Alg.* ii. 186.

CYLINDROS'PORUM, Grev.—A supposed genus of parasitic Fungi, stated by Tulasne to consist of the conidiiferous forms of Sphæriacei.

C. concentricum, Grev. = *Uredo cylindrospora*, Hook. *Br. Fl.*, grows upon the leaves of cabbages. It appears however, that Greville's plant is really a species of *Glœosporium*, and quite different from the fungi with which it has been confounded.

Bibl. Grev. *Sc. Crypt. Fl.* t. xxix.; Berkeley, *Hort. Tr.* iii. 265; Tulasne, *Ann. Sc. Nat.* 4 sér. v. 109; Berkeley, *Outl.* 325.

CYLINDROTHE'CA, Rab.—A genus of Diatomaceæ.

Char. Frustules fusiform, free, ends acute; with 2 (rarely 1 or 3) longitudinal flexuous costæ; no nodules.

C. Gerstenbergeri (Pl. 51. fig. 34). Living frustules cylindrical, obtusely attenuate at

ends; dried frustules fusiform, acuminate; length 1-90″. Common in pools and ditches (Germany).

Bibl. Rabenhorst, *Flor. Alg.* i. p. 145.

CYLINDROTHE'CIUM, Br. and Sch. =Neckera.

Bibl. Wilson, *Bryol. Brit.* p. 326.

CYMATONE'MA, Kütz. = undulate-constricted *Œdogonia*. (Rabenhorst, *Fl. Alg.* iii. 351.)

CYMATOPLEU'RA, Sm.—A genus of Diatomaceæ. This genus was founded by Hassall as *Sphinctocystis*, and should be retained (see the laws of nomenclature, in the *Ann. N. H.* 1843, ii. 259); but Smith's excellent Monograph has caused his term to be generally adopted.

Char. Frustules free, single; in front view linear, with undulate margins; valves oblong or elliptical, sometimes constricted in the middle. Freshwater.

Valves with coarse, transverse or nearly so, rounded elevations appearing as dark bands; an interrupted median line; coarse marginal dots, and transverse striæ; but neither alæ nor nodules.

Several British species.

S. solea (Pl. 16. fig. 23). Valves linear-elliptic, narrowed on each side towards the middle; transverse striæ evident; extreme length 1-216″. Undulations six; common.

β. Much shorter; undulations fewer, ends apiculate.

S. elliptica (Pl. 16. fig. 24). Valves broadly elliptic, or elliptic-oblong; striæ obscure; undulations four or five; length 1-280″; common.

S. hibernica. Valves broadly elliptic, acuminate; undulations three; length 1-25′0′.

Bibl. Hassall, *Algæ*, 436; Smith, *Br. Diat.* i. 36; Rabenhorst, *Fl. Alg.* i. 60.

CYMATOSIRA, Grun.—A genus of Diatomaceæ.

Char. Frustules united into bands; undulate in front view; valves lanceolate, distinctly punctate; no median line.

C. Lorenziana (Pl. 51. fig. 35). Valves broadly lanceolate, very convex; ends produced. At the bottom of the Adriatic.

Bibl. Rabenhorst, *Flor. Alg.* i. p. 124.

CYMBALO'PORA, Hagenow.—One of the *Foraminifera Globigerinida*, in which the spiral is merged in a cyclical growth at an early stage, the shell increasing by rings of sac-like chambers, which open into the hollow base of the trochoid shell. *C. Poeyi* (D'Orb.) (Pl. 24. f. 17) is the type.

Cymbalopora is rare in the Upper Chalk, and some Tertiary strata; more common in the tropical seas.

Bibl. Carpenter, *Foram.* 215.

CYMBEL'LA, Ag.—A genus of Diatomaceæ.

Char. Frustules solitary, free; valves cymbiform, unsymmetrical, with a subcentral and two terminal nodules, a submedian longitudinal line, and transverse or slightly radiating striæ. Freshwater and fossil.

Frustules sometimes immersed in an amorphous gelatinous mass.

C. Ehrenbergii, K. (Pl. 51. fig. 2: *a*, front view; *b*, side view). Broadly lanceolate, apices slightly produced, somewhat obtuse; striæ distinct (resolvable into dots); length 1-200″. (Fossil in San Fiore deposit.)

Several British species, and more foreign, differing from each other by slight characters.

Rabenhorst describes 31 European species, with numerous varieties.

Bibl. Smith, *Brit. Diat.* 17; Kützing, *Bacill.* 79, and *Sp. Alg.* 57.

CYMBOSIRA, Kütz.—A genus of Diatomaceæ.

Char. Frustules resembling those of *Achnanthes*; solitary or binate, stipitate, attached end to end, and thus concatenate. Marine.

C. Agardhii (Pl. 19. fig. 18). Frustules linear, slightly arcuate, finely striated, rounded at ends; valves oblong-linear, slightly dilated in the middle, apices obtusely rounded. Length 1-960 to 1-280″.

C. minutula, Grun.

Bibl. Kützing, *Bacill.* 77, and *Sp. Alg.* 57; Grunow, *Wien. Verh.* 1863.

CYNIPIDÆ, Gall-flies.—A family of Insects, belonging to the Entomophagous section of the order Hymenoptera.

Char. Head small, transverse; antennæ inserted in the middle of the face, of moderate length, slender, not geniculated, composed of twelve to fifteen joints; maxillary palpi of four or five, labial of two or three joints; thorax oval, gibbous, with the mesothorax large, and the scutellum very prominent; wings transparent, with few veins,—the anterior usually with three or four cells, and the posterior with a single vein; abdomen short, much compressed, with a short peduncle, its basal segment very large, the rest small, forming narrow rings.

In the females of these insects, which are all of small and some of minute size, the last segment of the abdomen, which occupies a considerable portion of its lower surface,

forms a channel, in which is lodged the very delicate ovipositor. This organ, the construction of which has been the subject of some controversy, consists, as pointed out by Westwood, of the same parts as that of the ordinary parasitic Hymenoptera (*Ichneumonidæ*, *Chalcididæ*, &c.), namely, of a superior bristle, channelled beneath, and of two finer inferior bristles, which are received into the channel of the former. Although this ovipositor is not exserted, it is of great length, reaching up to the base of the abdomen in a subspiral curve; it is enclosed at its base between two broad plates, representing the basal joints of the bivalvular sheath of the ovipositor in other Hymenoptera; and the slender second joints of these valves accompany it to the apex of the abdomen. All these parts are concealed within the walls of the abdomen (Pl. 36. fig. 15).

Although placed from their organization in the same section of the Hymenoptera as the parasitic Ichneumonidæ, most of the Cynipidæ feed upon vegetable substances in the larva-state. The females bore with their ovipositor into the tissues of plants and trees, and there deposit their eggs, from which small footless larvæ are produced. The irritation caused by the injury thus done to the tissues, gives rise to a morbid action in the part of the plant attacked, which is thus incited to grow out into an excrescence varying in size, form, and structure according to the specific nature of the plant, the part of the plant upon which, and the parasite by which, the wound has been inflicted. Thus the oak, which, of all our native trees, is most infested by Cynipidæ, furnishes nourishment to upwards of a dozen species, which attack all parts of it, from the leaves and flower-buds to the root, and each of which confines its operations to a particular portion of the tree, and gives rise to a peculiar excrescence. These morbid growths are commonly known as *galls*, and the insects producing them as *Gall-flies*; the family, also, is called *Gallicolæ* by some authors. The larvæ feed in the interior of the galls; those of some species are solitary, whilst of others numerous individuals may be found in the same gall, according as the parent insect has deposited one or more eggs in the same spot. When full-grown, the larvæ usually undergo their transformations within the gall; but in some instances they eat their way out, bury themselves in the ground, and there pass to the pupa-state. The larvæ are liable to be attacked by species of parasitic Hymenoptera, especially the long-tailed Chalcididæ (such as *Callimome*, Pl. 36. fig. 14); these pierce through the substance of the gall and deposit their eggs in or upon the Cynipidous larvæ, which are subsequently devoured by those hatched from the eggs of the parasite.

The recent elaborate researches of Adler show that the Cynipidæ exhibit the phenomena of parthenogenesis, and that they are dimorphic. Thus, in some broods, both sexes are present; while in others, females only are produced. The members of the two broods are quite dissimilar, and have been regarded as constituting different genera; the galls they produce are also different. These observations serve to solve the mystery existing some years ago as to the non-occurrence of males among large broods of *Cynips*. He also states that the reproductive organs in the two kinds of broods are very similar; and that there is a rudimentary receptaculum seminis in the agamic generations.

The tissues of the galls are sometimes soft and juicy, sometimes hard and woody; in the latter case the woody tissue lies immediately beneath the skin, and within it is a layer of cellular tissue filled with starch-grains. These galls are usually formed on branches or twigs. One of the most remarkable of them is the Bedeguar gall of the wild rose, which is produced by the puncture of *Rhodites Rosæ* (Pl. 36. fig. 16): it is a large gall entirely covered with compound bristles, like those of the moss-rose, which give it the appearance of a ball of moss; in its interior are numerous cells, each of which serves as a habitation for a larva; and the whole is produced at the extremity of a shoot of the wild rose, upon which the female gall-fly deposits numerous eggs.

The Cherry-gall of the oak-leaf is produced by *Cynips folii* (fig. 17), one of the commonest of our native species; and another gall-fly, *Teras terminalis* (fig. 18), by attacking the young shoots of the oak, gives origin to the well-known oak-apples. The leaves of the oak are also attacked by at least two so-called species of the genus *Neuroterus*, which really consists of the parthenogenetic brood of *Spathegaster*, the punctures of which give rise to small, flat, rounded galls, attached to the leaf only by a small portion of their lower surface, and

bearing so close a resemblance to certain Fungi, that they were at one time supposed to be parasitic vegetable growths. These galls, which are commonly known as *oak-spangles*, may be met with in abundance during the winter on the fallen leaves in oak woods: the flies are produced in the spring; and the most abundant species in this country is the *Neuroteris longipennis* (fig. 19). The root of the oak is attacked by several kinds, one of which, *Biorhiza aptera*, the parthenogenetic form of *Teras terminalis*, is destitute of wings; another deposits its eggs in the male catkins of the same tree, producing a series of galls resembling a small bunch of currants.

It would be impossible for us here to enumerate the different kinds of galls produced by these beautiful little insects even upon our indigenous plants and trees, the history of which in many cases is very imperfect, whilst we have scarcely any information with regard to exotic species. The most important of all is the common gall-nut, which is produced by the puncture of the *Cynips tinctoria* upon the shoots of the *Quercus infectoria*, a species of oak growing in the Levant. The celebrated Dead-sea apples are also found upon this oak; they are as large as a good-sized apple, and of a spongy texture internally, containing only a single larva of a species which has been described by Westwood under the name of *Cynips insana*.

All the species of Cynipidæ do not, however, produce galls. The species of Hartig's genus *Synergus* deposit their eggs in other galls, upon the substance of which the larvæ, when hatched, feed parasitically, and finally devour the original tenant. Besides these species, which live partly upon vegetable and partly upon animal food, there are many others, forming several genera in Hartig's classification, which live entirely as parasites upon other insects, especially *Aphides* and the larvæ of Dipterous flies; thus justifying the otherwise anomalous position of the Cynipidæ, as a phytophagous family in the Entomophagous group of the Hymenoptera. Amongst these we need only mention the species of the genus *Allotria*, Westw. (*Xystus*, Hartig), of which a very abundant one is parasitic upon the rose-Aphis, and those of the genera *Anacharis*, *Figites*, and *Ibalia*. The latter, of which one species only is known in this country, is remarkable from the structure of its abdomen, which is knife-shaped, and has the segments nearly equal in length; *Ibalia cultellata* (Pl. 36. fig. 20) is one of the largest British Cynipidæ.

Adler's admirable memoir, in which many of the galls are figured, will allow of the identification of most, if not all the British kinds.

Bibl. Réaumur, *Mémoires*; Burgsdorf, *Schriften Gesellsch. naturforsch. Freunde*, iv.; Boyer de Fonscolombe, *Ann. Sc. Nat.* xxvi.; Westwood, *Introd.* vol. ii., *Mag. Nat. Hist.* vi. and viii., and in Guérin's *Mag. Zoologie*; Walker, *Ent. Mag.* ii. & iii.; Brandt and Ratzeburg, *Medizin. Zool.* ii.; Ratzeburg, *Forst-Insecten*; Bouché, *Naturgesch. d. Insecten*; Hartig in Germar's *Zeits. für die Entomol.*; Adler, *Zeitschr. wiss. Zool.* liii. 151; *Abridg.* McLachlan, *Entom. Mn. Mag.* 1881, xvii. 258; *Jn. Mic. Soc.* i. 443; Ormerod, *Man. Inj. Ins.*, 1881.

CYNODON'TIUM, Br. and Sch.=Dicranum.

Bibl. Wilson, *Bryol. Brit.* 60.

CYNOPHAL'LUS.—A genus of Phalloidei (Gasteromycetous Fungi), distinguished from *Phallus* by having the pileus imperforate.

C. caninus occurs amongst decayed leaves in woods.

Bibl. Sow. t. 330; Berk. *Outl.* p. 298.

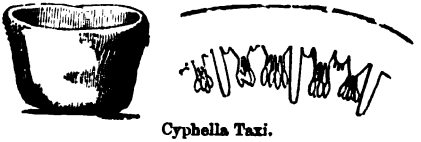
CYNTHIA, Sav.—A genus of Tunicate Mollusca, of the family Ascidiadæ.

The numerous species are from ½–2″ in length.

Bibl. That of the family.

CYPHEL'LA, Fries.—A genus of Hymenomycetes (Basidiomycetous Fungi),

Fig. 152. Fig. 153.



Cyphella Taxi.

Fig. 152. Entire plant, magnified 10 diameters.
Fig. 153. Horizontal section of the wall of the cup, showing the basidiospores, magnified 250 diameters.

forming somewhat membranous minute cups, sessile or stalked upon branches of trees or upon mosses; bearing basidiospores on a layer forming a kind of lining to the cup; the spores ultimately separating as a powder in the interior.

Some supposed species of *Peziza*, as *P. villosa* and *P. albo-violascens*, appear to be species of *Cyphella*, or rather sporiferous states of *Peziza*.

Bibl. Fries, *Syst. Myc.* ii. 201; Léveillé, *Ann. Sc. Nat.* 2 sér. xvi. 237.

CYPHID'IUM, Ehr.—A genus of Infusoria, of the family Arcellina.

Char. Carapace urceolate, tuberculated; expansion variable, broad, single and entire. The carapace is combustible, and resembles a small cube, with a short pedicle.

C. aureolum (Pl. 30. fig. 38). Cubical, gibbous, expansion (fig. 38 *b*) hyaline; fr. wat.; length 1-570 to 1-432″.

Bibl. Ehr. *Infus.* 135.

CYPHODE'RIA, Schlumb.—A genus of Rhizopoda, of the family Arcellina.

Char. Carapace membranous, resisting, ovoid, elongated in front, recurved and constricted in the form of a neck and marked with oblique rows of projections; orifice circular, oblique; expansions very long, filiform, very slender at the end, simple or branched.

Agrees with *Difflugia enchelys*, E. (*Trinema*, Duj.), in the oblique orifice, the oblique rows of markings, and the nature of the expansions, but differs from it in the presence of the anterior neck-like constriction.

Probably species of *Euglypha* (Cl. & L.).

C. margaritacea. Carapace yellowish, expansions twice its length; fr. wat.; length 1-380 to 1-180″.

Bibl. Schlumberger, *Ann. des Sc. Nat.* 1845, iii. p. 255.

CYPHONAU'TES, Ehr.—A genus of Rotatoria, of the family Megalotrochæa.

Char. Eyes absent; no teeth.

C. compressus (Pl. 43. fig. 19, side view; fig. 20, view from above). Compressed, obtusely triangular, truncate in front, subacutely gibbous at the back; marine; length 1-180″.

Bibl. Ehrenb. *Infus.* 395.

CYPREL'LA, De Koninck.—A fossil Ostracod, related to *Cypridina*; carapace annulated by superficial transverse furrows. Found in the Carboniferous Limestone of Belgium and the British Islands.

Bibl. De Koninck, *Carb. Foss. Belg.* 1844, 589; Jones, *M. Mic. Jn.* 1870, pl. 61. f. 10.

CYPRIDEL'LA, De Kon.—A fossil Ostracod closely allied to *Cypridina*. Very common in the Carboniferous Limestone of the British Isles and Belgium.

Bibl. De Koninck, *Carb. Foss. Belg.* 1844, 590; Jones, *M. Mic. Jn.* 1870, pl. 61. f. 9.

CYPRIDI'NA, M.-Edwards.—A genus of Ostracode Entomostraca, fam. Cypridinidæ.

Char. Valves oval or oblong, smooth, notched antero-inferiorly, posterior end somewhat produced. Superior antennæ seven-jointed; setæ of moderate length; natatory branch of inferior antennæ nine-jointed, bearing moderately long setæ; secondary branch very small, subulate. Basal joint of mandibular feet bearing an entire subconical and densely hairy process; penultimate joint much elongated, and beset on the internal margin with numerous ringed setæ; last joint very short and almost obsolete.

2 European species: *C. Norvegica* and *C. Messinensis.*

Many fossil forms, apparently identical with *Cypridina*, occur in the Mountain-limestone and the Coal-measures of Europe and the British Isles; some also in the Maestricht Chalk.

Bibl. Brady, *Zool. Proc.* 1871, 289; M.-Edwards, *Hist. Nat. Crust.* iii. 409; Jones, K., & B., *Mongr. Carb. Entom., Pal. Soc.* 1871.

CYPRID'IUM.—A genus of Hypotrichous Infusoria (Kent, *Inf.*, 215).

CYPRIDOP'SIS, Br.—A genus of Ostracode Entomostraca, family Cypridæ.

Char. Those of *Cypris*, except that the post-abdominal rami are rudimentary and setiform.

5 living British species. *C. vidua*, Br. = *Cypris vidua*, Bd.; *C. villosa*, Br. = *Cypris Westwoodii*, Bd.

Bibl. Brady, *Linn. Tr.* xxvi. 375; *Ann. Nat. Hist.* 1872, ix. 64.

CY'PRIS, Müller.—A genus of Ostracode Entomostraca, family Cypridæ.

Char. Lower antennæ simple, with a brush of setæ and clawed at the apex; setæ of upper antennæ very long; feet two pairs, the last bent up between the valves. Post-abdominal rami forming two elongate rami, clawed at the apex. Animal swimming freely.

Body enclosed within a bivalve, horny, mostly subreniform or long oval carapace or shell. Superior antennæ (Pl. 20. fig. 18) seven-jointed, with pretty long, mostly feathery filaments, arising from the three or four last joints. Inferior antennæ (fig. 19) leg-like, five-jointed, giving off the tuft of usually feathery filaments, the last joint terminated by four strong curved claws. Labrum composed of a somewhat hood-shaped piece, projecting between the two

inferior antennæ; labium or lower lip elongated and triangular. Mandibles (fig. 20) large, pointed at one end, with five teeth at the other, and furnished with a three-jointed setigerous palp, the basal joint of which has a small branchial joint with five terminal digitations. First pair of jaws (fig. 21) consisting of a large basal plate (*a*), with four finger-like processes at its anterior extremity, one of which is two-jointed, and all terminated by several long filaments; from the outer edge of this plate arises a large elongated branchial lamina (*b*) giving off from its crescentic margin nineteen long pectinate spines. Second pair of jaws (fig. 22) small, and composed of two flattened joints, the terminal one having several rigid hairs at the end, and a lateral palp-like process. First pair of feet (fig. 23) slender and five-jointed, the last joint with a strong hook. Second pair of feet (fig. 24) four-jointed, the last joint terminated by two short hooks and a spur-like posterior filament.

Twenty-seven living British species.

C. virens (*tristriata*, Bd.) (Pl. 20. figs. 17-25). Shell oval, and somewhat reniform, posteriorly exhibiting three narrow oblique streaks or dark bands; valves convex, green, and covered with dense short hairs. Near the centre of each valve are about seven small lucid spots. Fr. wat. very common.

Several fossil Ostracoda are referred to *Cypris* by palæontologists.

Bibl. Baird, *Entom.* 151; Straus, *Mém. d. Mus. d. Hist. Nat.* vii. 1821; Edwards, *Hist. N. Crust.* iii.; Brady, *Linn. Tr.* xxvi. 360, and *Ann. N. H.* 1872, ix. 64; Rup. Jones, *Mon. Tert. Entom.*, *Palæont. Soc.* 1836; *Geol. Mag.* vii. 158.

CYRTOSTOMUM, Stein.—A genus of Holotrichous Infusoria.

C. leucas = *Bursaria* (*Frontonia*) *l.*

CYSTIC OXIDE or CYSTINE.—A very rare component or constituent of urinary calculi in man and the dog. It is stated also to occur in the urine, in solution and as a crystalline deposit; but we have never met with it.

Cystine is insoluble in water and alcohol; soluble in mineral acids, but not in acetic acid; also soluble in solutions of fixed alkalies, their carbonates, and in solution of ammonia. It is precipitated from its solution by acetic acid.

Its crystals form colourless, regular six-sided plates or prisms (Pl. 13. group 5); the larger crystals usually exhibit a number of smaller hexagonal tables irregularly arranged upon them; sometimes rectangular plates are met with. The crystals usually exhibit but little colour with polarized light. Cystine is most readily obtained in crystals from a calculus by solution in ammonia and spontaneous evaporation.

Some of the forms of lithic acid prepared artificially, resemble those of Cystine (Pl. 12. group 8 *b*); they may be distinguished by the addition of ammonia, which dissolves the cystine, but has little or no action upon the uric acid.

Carbonate of potash also somewhat resembles cystine in the form of its crystals (Pl. 10. fig. 13); but water or acetic acid will at once distinguish them.

CYSTICER'CUS, Rud.—Formerly considered a genus of Cystic Entozoa; but now known to be the scolices of *Tænia*. They consist of the short body of a *Tænia*, with the double crown of hooks and the suckers, terminated posteriorly by a larger or smaller cyst or vesicle. They occur in the organs and the tissues of animals; when reaching the alimentary canal, becoming developed into the perfect *Tæniæ*. They have no sexual organs.

C. cellulosæ (Pl. 21. fig. 3), the most common, is the scolex of *Tænia solium*. The head is almost tetragonal, neck very short; body cylindrical, often longer than the vesicle; breadth of cyst half an inch; length of body, 1-6 to 2-5″, or 1″ when extended. Occurs in the anterior chamber and beneath the conjunctiva of the eye, also in the voluntary muscles and brain of man; in the connective tissue of the pig, producing "measly pork;" also in the ape, the dog, the ox, &c. *C. tenuicollis* of the sheep is the scolex of *T. marginata* of the dog; *C. fasciolaris*, of the rat and mouse (Pl. 21. fig. 3 *b*, head) = *T. crassicollis* of the cat; *C. pisiformis* of the rabbit = *T. serrata* of the dog; *C. talpæ* and *C. longicollis*, infesting moles, become respectively *T. tenuicollis* and *T. crassiceps* of the fox.

Bibl. Dujardin, *Helm.* 632; Monier, *Cysticerq.* 1880; Beneden, *Vers Cestoïden*; Cobbold, *Parasites*, and the Bibl. of Tænia.

CYSTINE. See Cystic Oxide.

CYSTOCOC'CUS, Näg. = Protococcus.

CYSTOPHRYS, Archer.—A genus of Rhizopoda

2 species: *C. Häckeliana* and *C. oculea*.

Bibl. Archer, *Qu. Mic. Jn.* 1869, 259.

CYSTOP'TERIS, Bernhardi.—A genus of Davallieæ (Polypodiaceous Ferns), con-

Fig. 154.

Cystopteris fragilis.
A pinnule with the sori covered by the indusia.
Magnified 10 diameters.

taining several elegant little indigenous species (fig. 154).

BIBL. Hooker and Baker, *Syn. fil.* 103.

CYS'TOPUS, Léveillé.—A genus of Uredinei (Phycomycetous Fungi), of which the 'white rust' common on cabbages and other Cruciferous plants is a good example; appearing in white pustules, eventually bursting and destroying the epidermis of the leaves, stalks, flowers, and seed-vessels of the infected plants. When fine slices of these pustules are examined under the microscope, the mycelium is found, creeping among the cells of the parenchyma, composed of inarticulate, tubular, branched filaments, with a colourless membrane and whitish granular contents. Numerous ramifications spread out in the plane of the epidermis; while others spring up in tufts of two to seven, or rarely singly, perpendicular to the former, to produce spores. These erect branches are at first mere pouches projecting from the horizontal filaments; they gradually swell into ovate-cylindrical or club-shaped sacs. The contents in the summit of each such sac become organized into a spore, which at length quite fills up the top of the sac (sporange). Then the sac or sporange becomes constricted under this first spore, and the formation of a second commences under the constriction. This is repeated until a necklace-like chain of spores is produced, the spores subsequently becoming somewhat cylindrical or cubical. The number appears indefinite; five and seven spores have been found in a chain; they are united by the constricted portions of the sporange; and even when they have fallen apart, these connecting pieces are seen projecting on them like parts of a stalk from which they have been broken off. Both the adherent sporangial membrane and the smooth proper coat of the spores are colourless, the contents granular and whitish. Tulasne has recently discovered another form of spore, spheroidal or trigonal, and of a yellow colour, only one or two of which are formed from the end of a fertile filament. Oospores are also found deeply seated amongst the mycelium; and zoospores (Pl. 27. fig. 14) have been found by De Bary in *C. candidus*. See UREDINEI. British species; formerly placed in the Uredinei, but more nearly allied to *Peronosporæ*:—

C. candidus. Lév. Very common on Cruciferæ, producing great distortion in the growth. *Uredo candida*, Pers., Grev. *Sc. Crypt. Fl.* t. 251.

C. cubicus, Str. On goatsbeard. Cooke, *Exs.* no. 88.

C. Sepigoni, De By. On *Spergularia rubra*. Cooke, *Exs.* no. 88.

C. spinulosus, De By. On *Cirsium arvense*. Cooke, *Exs.* no. 89.

BIBL. Léveillé, *Ann. Sc. Nat.* 3 sér. viii. 369; Berkeley, *Hort. Trans.* iii. 265 (figs.); De Bary, *Brandpilze*, Berlin, 1853, p. 20, pl. 2. figs. 3–7, and *Ann. Sc. Nat.* 1863, xx. 130 (zoospores); Tulasne, *Ann. Sc. Nat.* 4 sér. ii. 108, 171; Sachs, *Bot.* 279.

CYSTOSEI'RA, Ag.—A genus of Fucaceæ (Fucoid Algæ), of much-branched habit, some species of which are common on rocks in tide-pools or between tide-marks. The gradually attenuated branches contain inflated air-sacs, at intervals along their length, within their substance. The conceptacles are immersed in the ends of the branches, which are pierced by their numerous pores. They contain both spores and antheridia, but not mixed; the spores occur at the bottom of the cavity, the antheridia above, near the pore. The antheridia have only a single coat. The antherozoids are expelled in a mass, and soon after begin to move, turning rapidly upon their axes. They are oval or spherical in one direction, and rather compressed in the other. They have two cilia inserted on a red granule; the long cilium in front moves rapidly, while the posterior short one is motionless. See FUCACEÆ.

BIBL. Harvey, *Mar. Alg.* pl. 1 B; *Phyc. Brit.* 133, &c.; Thuret, *Ann. Sc. Nat.* 3 sér. xvi. pp. 7 & 10.

CYSTOT'RICHA, Berk. and Broome.—A supposed genus of Sphæronemei (Coniomycetous Fungi). Minute fungi forming dots or lines upon wood from which the bark has been stripped. Only one species is described.

C. striola, Berk. and Br. Perithecia black, with a reddish tinge, opening by a reddish disk.

BIBL. Berk. and Br. *Ann. N. H.* 1850, v. 457, pl. 12. fig. 10.

CYTH'ERE, Müll.—A genus of Entomostraca, of the order Ostracoda, and family Cytheridæ.

Char. Shell usually hard, calcareous, rough and uneven; mouth with a lip and labrum; masticatory organs well developed; mandibles toothed at the end; lower antennæ four-jointed; upper antennæ five-jointed, last three joints elongated, spiniferous; feet in the male and female alike; internal lobe of the first pair of maxillæ well developed. Not capable of swimming.

Those having the valves almost regularly oblong, with the surface very irregular, being wrinkled, ridged, and beset with tubercles, and crenulate or strongly toothed on the margin, have been separated by Rupert Jones under *Cythereis*.

46 living British species. Many fossil Cytheræ are recorded, which, however, most probably belong to allied genera, undistinguishable by the valves alone. Brady records 22 species as occurring in post-tertiary deposits of Britain.

BIBL. Baird, *Brit. Entom.* 163; Brady, *Linn. Tr.* xxvi. 394, and *Ann. N. H.* ser. 4. ix. 68; *Zool. Tr.* v. 376.

CYTHERE'IS, Rup. Jones. See CYTHERE.

CYTHEREL'LA, R. Jones and Bosquet.—A genus of Ostracode Entomostraca, family Cytherellidæ.

Char. Valves unequal, very thick and calcareous, not notched in front. Upper antennæ very large, seven-jointed, and geniculate at the base; lower broad, flattened, and two-branched; mandibles very small, with a large pectinate-setose palp; three pairs of hinder limbs, scarcely pediform, the two anterior pairs branchial, the others rudimentary. Abdomen terminating in two very small, narrow, spiniferous laminæ. Ova and embryos borne beneath the shell of the female.

2 living British species, *C. scotica* and *C. lævis*; from deep dredging in the Minch. Numerous fossil species, from the Carboniferous to Tertiary strata inclusive.

BIBL. Brady, *Linn. Tr.* xxvi. 472; *Zool. Tr.* v. 362; R. Jones, *Mon. Cret. Entom.* 1849, 28; *Mon. Tert. Entom., Palæont. Soc.* 1856, 54.

CYTHERELLI'NA, Jones.—An obscure fossil Ostracod, very common in the upper Silurian strata of Britain and Europe.

BIBL. R. Jones, *Ann. N. H.* ser. 4. iii. 215.

CYTHERID'EA, Bosquet.—A genus of Ostracode Entomostraca, family Cytheridæ.

Char. Shell subtriangular, thick and compact, smooth, pitted, papillose or rugose. Mouth with a lip and labrum; masticatory organs well developed; mandibles toothed at apex; lower antennæ four-jointed; upper five-jointed, last three joints elongated, spiniferous; feet in male and female unlike; right foot of first pair in the male prehensile, right of the second pair weak and rudimentary.

10 living British species. Several fossil Cretaceous and Tertiary species.

BIBL. Brady, *Linn. Tr.* xxvi. 421; *Zool. Tr.* v. 370; R. Jones, *Mon. Tert. Entom., Pal. Soc.* 1856, 40, and *Geol. Mag.* vii. 76, 158.

CYTHERIDE'IS, Jones.—A subgenus of Ostracode Entomostraca.

1 living British species, *C. subulata*; some fossil reputed species, Cretaceous and Tertiary.

BIBL. Jones, *Monogr. Tert. Entom., Palæontog. Soc.* 1856, 46 (shell); Brady, *Ann. N. H.* 1872, ix. 58 (animal).

CYTHEROPSIS, Sars = *Eucythere*, Brady.

CYTHEROP'TERON, Sars.—A genus of Ostracode Entomostraca.

Char. Valves of shell unequal, with prominent lateral alæ. Mouth with labium and labrum; masticatory organs well developed; mandibles toothed; lower antennæ five-jointed; upper five-jointed; postabdominal lobes broad and short, with three setæ; eyes none.

9 living British species. Also some Cretaceous and Tertiary species.

BIBL. Brady, *Linn. Trans.* xxvi. 447, and *Ann. N. H.* 1872, ix. 61; R. Jones, *Geol. Mag.* vii. 76 and 158.

CYTHERU'RA, Sars.—A genus of Ostracode Entomostraca.

Char. Shell oblong or subtriangular, posterior extremity prolonged into a beak. Superior antennæ six-jointed, shortly setose,

tapering; inferior antennæ five-jointed; terminal claws short; mandibles robust; teeth blunt; eyes two.

24 living British species; also some Cretaceous and Tertiary species.

Bibl. Brady, *Linn. Tr.* xxvi. 439, and *Ann. N. H.* 1872, ix. 55; R. Jones, *Geol. Mag.* vii. 77, 158.

CYTIS'PORA, Ehrenb.—A genus of Sphæronemei (Coniomycetous Fungi), remarkable for emitting the minute bodies formerly regarded as spores, agglutinated together into a more or less gelatinous mass, in the form of a tendril. The relationship between the forms called *Cytispora* and various species of *Sphæria* has long been noticed; and Fries stated that he had seen *C. leucostoma* pass into *S. leucostoma*. *C. fugax* was stated by Berkeley to be exactly analogous to *S. salicina*. Recent researches seem to prove that the present genus, with *Septoria* and others, are really only forms belonging to various Ascomycetous Fungi, and that they bear the same relationship to the latter as the spermogonia of Lichens do to the theciferous fructification. Hence the so-called spores of *Cytispora* &c. appear in reality to be the *spermatia* or *stylospores* of the Sphæriacei. As these questions are not yet completely worked out, we retain the names of these pseudo-genera and species at present. See Sphæriacei.

Cytispora rubescens, Fr. Disk dirty brown; spores (?) reddish. On Rosaceæ.

C. chrysosperma, Pers. Disk black; spores yellow. On Poplar bark.

C. carphosperma, Pers. Disk dingy; spores straw-coloured. On Hawthorn and other Rosaceæ.

C. leucosperma, Pers. Disk dirty white; spores white. On various trees. Common. *Nemasporum rosarum*, Grev. *Scot. Crypt. Fl.* t. 20.

C. fugax, Bull. Disk dirty brown; spores pale. On Willow branches. Very common.

C. orbicularis, Berk. Disk yellowish; spores pale vinous red. Upon small orange gourds. Berkeley, *Ann. Nat. Hist.* i. pl. 7. fig. 6.

C. Hendersoni, Berk. and Broome. Disk whitish; spores large, dirty white. On Dog-rose. Berk. and Br. *Ann. Nat. Hist.* 2 ser. v. 379.

C. pulveracea, Berk. *Br. Flora* = *Ceuthospora phacidioides*, Desm.

Bibl. Berkeley, *Brit. Flor.* vol. ii. pt. 2. 281, *Crypt. Bot.* 331; Berk. and Broome, *Hooker's Jn. of Bot.* iii. 319; Tulasne, *Ann. Sc. Nat.* 3 sér. xv. 375 (*Ann. N. H.* 2nd ser. viii. 114); *Ann. Sc. Nat.* xx. 129; *ibid.* 4 sér. v. 115; *Bot. Zeit.* xi. 49 (1853).

CYTOBLAST. See Nucleus.

CYTOBLASTE'MA, Blastema, or Protoplasm.—The amorphous proteine-substance of which animal and vegetable cells are more or less entirely composed. See Cells, and Protoplasm.

CY'TODE.—A term applied by Häckel to an organism consisting of a simple lump of sarcode = to our protoplast (1866).

Bibl. Häckel, *Gen. Morph.* i. 269.

CYTOLEI'CHUS, Mégn.—A genus of Acarina, near to *Sarcoptes*.

C. sarcoptoides, has the body rounded, the rostrum obtuse, and the tarsus of the 2nd pair of legs with a short cirrus directed upwards or outwards. In the air-sacs and bronchi of the Gallinæ.

Bibl. Mégnin, *Parasites*, 153.

D.

DACRY'MYCES, Fries.—A genus of Tremellini (Hymenomycetous Fungi), consisting of lobulated gelatinous bodies growing upon wood. *D. stillatus*, a very common species on moist rotting wood, is orange, turning brown when dried. Tulasne has published some curious observations on this genus, showing that the spores produced on the basidia of the external hymenial layer, are of two kinds; of which one kind germinates, while the other produces minute stalked bodies, one from each chamber of the septate spore, destitute of germinative power (*spermatia*?) (Pl. 27. fig. 5).

Bibl. Berkeley, *Hook. Brit. Fl.* v. pt. 2. 210; *Crypt. Bot.* 353; Greville, *Sc. Crypt. Fl.* pl. 159; Tulasne, *Ann. Sc. Nat.* 3 sér. xix. 211, pl. 12 & 13.

DACTYLI'NA, Nyl.—A doubtful genus of Lichens.

D. arctica, Hook., a singular fungus-looking plant, inhabits Arctic America.

Bibl. Leighton, *Linn. Jn.* ix. 192, pl. 2. figs. 11–17.

DACTYLIUM, Nees.—A genus of Mucedines (Hyphomycetous Fungi), nearly allied to *Trichothecium*, consisting of moulds growing over decaying plants. Fries refers Corda's species of *Dactylium* to *Dendryphium*. One species, *Dactylium oogenum*, Montagne, is remarkable for its place of

occurrence: it grows upon the surface of the membrane within the shell of the eggs of fowls and other birds. It does not appear to have been observed in this country; but several foreign writers have investigated it; and from the experiments made by Spring and Wittich, it appears that the spores pass through orifices existing in the shell, and germinate in the interior, often in the air-chamber. A full account of this plant, and of the literature, is given by Ch. Robin. Many of the species are undoubtedly coniferous forms of *Sphæriæ* (Tulasne, *Carpologia*). See DENDRYPHIUM and HELMINTHOSPORIUM. British species:

Fig. 155.

Dactylium atrum. A fertile filament with septate spores upon its branches. Magn. 200 diams.

D. pyriforme, Fr. On mouldering stems of herbaceous plants.

D. macrosporum, Fr. On rotton wood, leaves, and fungi.

D. dendroides, Fr. On decaying agarics, &c. Very common. Grev. *Sc. Crypt. Fl.* pl. 126. fig. 1.

D. obovatum, Berk. On willow twigs, in damp. *Ann. Nat. Hist.* vi. pl. 14. fig. 26.

D. sphærocephalum, Berk. On dead ivy-twigs, *l. c.* fig. 27.

D. tenellum, Fr. On moss.

BIBL. Berk. in *Hook. Brit. Fl.* v. pt. 2. 345; *Ann. N. H. ut supra*; Berk. and Broome, *Ann. N. H.* 2 ser. vii. 102; Robin, *Parasites*, 2nd ed. 543, pl. 2. figs. 5 & 6; Fries, *Syst. Myc.* iii. 414; *Summa Veget.* 491.

DACTYLOCOC'CUS, Näg.—A genus of Palmellaceous Algæ, allied to *Characium* and *Hydrianum*.

Char. Cells oblong or fusiform, free, 2–8 together, then separating. Two species, one green; among other Algæ, or on the side of pools; about 1-2500″ long.

BIBL. Nägeli, *Einz. Alg.* p. 85; Rabenhorst, *Fl. Alg.* iii. p. 46 (fig.).

DACTYLOP'ORA, Lam.—Regarded by some as one of the *Foraminifera imperforata*; but by others as belonging to the calciferous Algæ. The simplest form presents a set of sac-like chambers, side by side, for a part or the whole of a circle, with their mouths in one direction along the inner median line. Various modifications lead to the structure of a cylinder of such rings, with interspaces, thickened walls, and subsidiary cavities. The simple forms (*D. eruca*, Pl. 23. f. 53) live in the tropical seas. The more complicated species are of Tertiary age in France, Italy, and San Domingo; *D. reticulata* (Pl. 23. f. 54) is one of these.

BIBL. Parker and Jones, *Ann. N. H.* ser. 3. 473; Carpenter, *For.* 127; Gümbel, *Abh. bay. Akad.* 1872.

DACTYL'OPUS, Claus.—A genus of Entomostraca, order Copepoda.

D. tisboides. Marine.

BIBL. Claus, *Copepod.* 127; Brady, *Trans. Northumberland.*

DALTO'NIA, Hook. and Tayl.—A genus of Pleurocarpous Mosses, the species given being restored here on account of the structure of the leaf; while *D. heteromalla* of Hooker goes to *Hypnum* on the same ground.

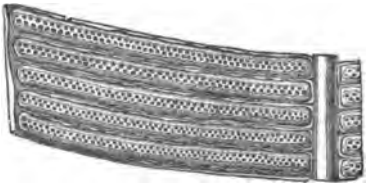
D. splanchnoides, Hook. and T. = *Hookeria splanch.* Hook.

DAMÆ'US, Koch. See BELBA.

DAM'MARA-"*Gum*."—The resin of *Dammara australis*, N. O. Pinaceæ. It is often used, dissolved in benzole, as a varnish; and as it dries quickly, it is useful. It is also largely used as a substitute for Canada balsam; but we prefer the latter.

DANÆ'A, Smith.—A genus of Marattiaceous Ferns, whence the family is sometimes called also Danæaceæ. Tropical America.

Fig. 156.



Danæa. Part of a pinnule with sori. Magnified 5 diameters.

12 species.

BIBL. Hooker and Baker, *Syn.* 442.

DAPH'NE, L. See THYMELEACEÆ.

DAPHNEL'LA, Baird.—A genus of Entomostraca, of the order Cladocera, and family Daphniadæ.

Char. Inferior antennæ very large, posterior branch two-jointed only.

D. Wingii (Pl. 20. fig. 27). Fresh-water.

BIBL. Baird, *Brit. Entomos.* 109.

DAPH'NIA, Müll.—A genus of Entomostraca, of the order Cladocera, and family Daphniadæ.

Char. Head produced into a more or less prominent beak; superior antennæ situated beneath the beak, either one-jointed or consisting of a minute tubercle with a tuft of short filaments; inferior antennæ large and powerful, two-branched, one branch three-jointed, the other four-jointed; five pairs of legs.

Valves of the carapace finely reticulated, and terminated below by a longer or shorter serrated spine. Anterior branch of inferior antennæ (Pl. 20. fig. 28 *b*) four-jointed, first joint very short; from the end of the third a long filament arises; and the fourth joint is terminated by three others; posterior branch three-jointed, the first and second joints sending off a long filament, the third terminated by three of them; the filaments are jointed near the middle, and usually feathery. Eye spherical, with about twenty lenses. Labrum (Pl. 20. fig. 35) flattened, and with a large hairy lobule at the end. Mandibles (Pl. 20. fig. 34) consisting of a fleshy-looking body, bent inwards near the end, and terminated by numerous minute teeth. Jaws (Pl. 20. fig. 36) composed of a strong body terminated by four horny spines, three of which are curved inwards. Legs five pairs, those of the first pair in the female (Pl. 20. fig. 29) three-jointed; upon the outer edge of the second joint are three small projections, each with four or five long jointed setæ; terminal joint very small, and with one or two similar setæ; the setæ not plumose. In the male they are more slender, with a strong claw at the end of the second joint, while the seta arising from the terminal joint is very long, nearly the length of the body, and floats outside the shell.

The second (Pl. 20. fig. 30), third (fig. 31), and fourth (fig. 32) pairs of legs are branchial and somewhat similar, the joint furnished with jointed and mostly plumose setæ, and a branchial plate also giving off numerous plumose setæ. The fifth pair of legs (fig. 33) are three-jointed, the portion corresponding to the branchial plate rounded and without filaments; above this is a curved, jointed, and plumose spine, the third and fourth joints forming finger-like processes springing from the lower end of the leg, with two or three plumose setæ. The branchial legs are constantly in motion during life; and this gives rise to the quivering appearance seen in the *Daphniæ* with the naked eye or a simple lens.

The ova on their escape from the body become lodged between the back of the animal and the shell, where they remain until completely hatched; but at certain seasons of the year ephippial or winter ova (Pl. 20. fig. 37) are produced (ENTOMOSTRACA).

According to Lubbock's observations, the latter only are true ova; although both kinds become hatched and perfectly developed, this may occur without impregnation.

Seven British species of *Daphnia* are recognized: some of them may be found in almost every collection of water, which they frequently colour.

D. pulex (Pl. 20. fig. 28) (common water-flea). Valves oval, their dorsal margin not serrated; head large, rounded above and in front; superior antennæ (Pl. 20. fig. 28 *a*) very small; filaments of inferior antennæ plumose; posterior portion of abdomen with four projections at its curve, the first prolonged and bent upwards; below these are two jointed filaments; the end portion has two dentate arches, and terminates in two strong hooks.

Some other species are common; but their essential characters have not been briefly expressed.

BIBL. Baird, *Br. Entom.* 89; Lubbock, *Ann. N. H.* 1857, xx. 257; Leydig, *Daphnid.* 1860; Weismann, *Daphniden*, 1877, and *Zeitschr. wiss. Zool.* 1876, 7.

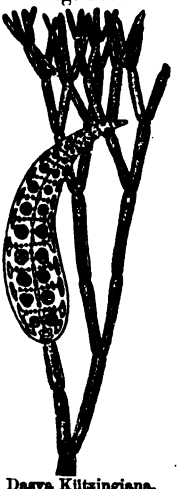
DARWINEL'LA, Brady, (= *Polycheles*, B.). —A genus of Ostracode Entomostraca.

1 British species: D. *Stevensoni*.

BIBL. Brady, *Ann. N. H.* ser. 4. vi. 25.

DA'SYA, Ag.—A genus of Rhodomelaceæ (Florideous Algæ), consisting of tufted filamentous sea-weeds, of a red, brown, or purple colour, growing on rocks near low-water mark.

Fig. 157.



Dasya Kützingiana, with a stichidium and two rows of tetraspores. Magnified 50 diameters.

The principal filaments are stoutish, branched, and clothed with branched ramules, upon which are borne the *stichidia* containing tetraspores (fig. 157), or *ceramidia* containing spores, on distinct plants. Four British species are recorded, of which *D. coccinea* and *D. Arbuscula* (Pl. 4. fig. 9) are the commonest.

Bibl. Harvey, *Mar. Algæ.* 93, pl. 12 B; *Phyc. Brit.* pl. 40, 224, 225 & 253.

DASY'DYTES, Gosse.—A genus of Rotatoria, of the family Ichthydina.

Char. Eyes absent; body furnished with bristle-like hairs; tail simple, truncate.

D. goniathrix. Hairs long, each hair bent at an abrupt angle; neck constricted; length 1-146″; fr. wat.

D. antenniger. Hair short, downy; a pencil of long hairs at each angle of the posterior extremity of the body; head with two club-shaped organs resembling antennæ; length 1-170″.

Bibl, Gosse, *Ann. N. H.* 1851, viii. 198.

DASYGLŒ'A, Thwaites.—A genus of Oscillatoriaceæ (Confervoid Algæ).

D. amorpha (Pl. 8. fig. 11) forms a shapeless gelatinous stratum, consisting of curled and entangled filaments, with very large sheaths, open at the ends; in marshy places.

Bibl. *Eng. Bot. Supp.* 2941; Kützing, *Sp. Alg.* 272; *Tab. Phyc. Cent.* i. pl. 72. fig. 2.

DATE.—The fruit of the Date-palm, *Phœnix dactylifera*, N. O. Palmaceæ. Roasted dates are used to adulterate real coffee; a so-called date-coffee is also manufactured from the entire fruit, or from the seed (perisperm) only. The principal tissues of the latter are represented in Pl. 2. fig. 9.

DAVAL'LIA, Sm.—A very large genus; tropical.

Bibl. Hooker, *Syn.* 88.

DAVALL'IEÆ.—A family of Polypodiaceous Ferns.

Fig. 158.

A pinnule with sori. Magn. 5 diam.

Fig. 159.

A sorus with the indusium cut open. Magn. 15 diam.

Davallia pyxidata.

Davallia. Sori globose or elongate, intra- or sub-marginal; indusium terminal on the veins; somewhat urn- or cup-shaped, the mouth truncated (figs. 158 and 159), apex free; veins pinnate.

Cystopteris. Sori globose, on the back of the veins; involucre membranous, sub-orbicular, inserted by its broad base under the sorus, which at the beginning it covers like a hood; fronds two or three times divided, thin, veins free.

DEGENERATION, FATTY.—The abnormal deposition of free fatty matter in the histological elements of animal bodies.

When, from whatever cause, the normal functions of the morphological element of a tissue—cells, or the secondary deposits formed in them—become languid or interrupted, free globules of fat or oil become deposited in them; and as this fatty matter increases in amount, the tissue loses to a greater or lesser extent its natural vital and physical properties; hence it is said to be in a state of fatty degeneration. The discovery of the fatty degeneration of tissues is probably one of the most valuable fruits of microscopic study in regard to medical science; for it has shown us that maladies supposed formerly to arise from too great abundance of the circulating fluid, have really had their origin in a decayed state of the tubes or vessels in which the fluid was contained, and that the natural process of human decay, as it is called, is a morbid process or disease, probably to a certain extent as remediable or preventible as many other diseases to which man is naturally liable. Here is indeed a matter of deep interest.

In addition to the deposition of fat within the elements of a tissue undergoing fatty degeneration, amorphous finely granular proteine-matters are sometimes found; occasionally also brown, yellow, red, or black granular pigment is met with (pigmentary degeneration), together with amorphous or crystalline calcareous salts, as the carbonate and phosphate of lime &c. (calcareous degeneration); sometimes the fatty matter is crystalline, it then generally consists of cholesterine.

Fatty degeneration of cells is well seen in those of the liver when undergoing this change. In the normal state, these as well as most cells, except those of true fatty tissue, contain merely one or two very minute or no globules of fat,—whilst in the degenerated tissue they contain a considerable number of larger or smaller globules (fig. 160). At the same time, the cell-walls and

nuclei become thinner and paler, or atrophied. A similar state to that which is abnormal in man, is normal in the lower animals. Sometimes the substance intervening between cells becomes degenerated; and thus

Fig. 160.

Cells of the human liver; *a*, nearly normal cells; *b*, cell with pigment granules; *c*, cells containing fatty matter.

Magnified 400 diameters.

we have intercellular fatty degeneration (Pl. 38. fig. 15). Other instances of fatty degeneration are noticed under the respective heads of the tissues &c., as the Graafian vesicles and the cells of the corpora lutea (OVARY), the epithelia of the mucous and serous membranes, and of the various glands, the vessels, the exudation-corpuscles of inflammation, the muscles, &c.

The fatty degeneration of the capillaries is represented in Pl. 38. fig. 13. In the larger blood-vessels, when reaching a more advanced degree, it forms atheroma.

It might appear paradoxical to regard the presence of numerous fat-globules, in such instances as the cells of cancer, and the exudation-cells of inflammation, where the vital processes are so evidently augmented, as indicating a state of degeneration. But in these, as in other instances, the functions of the cells, after the latter have attained their full development, cease, and the cells undergo degeneration and decay.

The free fatty matter is probably derived in general from the liberation of that previously dissolved in the contents of the cell; but it may be produced by the formation of fatty matter from the proteine or other constituents of the cell-contents. It is curious that portions of the flesh and other proteine-components of one animal, when kept in the peritoneal cavity of another living animal, will undergo fatty degeneration. The formation of adipocere seems to be an instance of post-mortem fatty degeneration.

Amyloid degeneration is noticed under AMYLOID.

BIBL. Virchow, *Path. Cell.* 1861; Wedl, *Path. Hist.*; Forster, *Spec. Path. Anat.*; Wagner, *Nachr. d. Ges. d. Wiss. z. Göttingen*, 1851 (*Chem. Gaz.* ix. 309); Green, *Path.* 31, 1871; Rindfleisch, *Lehrb. Geweb.* 1878, 46.

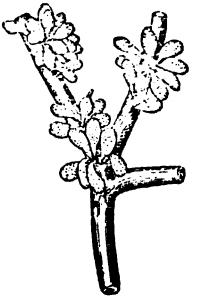
DELAVA'LIA, Brady.—A genus of Entomostraca, order Copepoda.

D. palustris. Northumberland.

BIBL. Brady, *Trans. Northumberland &c.*, & *Copepoda* (*Ray Soc.*).

DELESSE'RIA, Lamx.—A genus of Delesseriaceæ (Florideous Algæ), consisting of sea-weeds with a flat, membranaceous, rose-coloured frond, having a percurrent midrib, growing on rocks or on other larger Algæ, mostly from 2 to 8 inches high. Six species are described as British, most of them common. The leaf-like lobes of the frond arise from a kind of stalk, or from the midribs of older lobes. The texture is densely parenchymatous throughout. *D. sanguinea* (Pl. 4. fig. 5) ripens its fruit in the winter; and then the membranous part of the fronds decays, leaving the midribs clothed with tufts of the *sporophylls* or leafy lobes containing the tetraspores (fig. 161), and stalked coccidia containing the spores. The fructification is somewhat similar in *D. alata*, while in *D. sinuosa* the coccidia are immersed in the frond, and the tetraspores in cilia-like processes fringing its margin; and in *D. Hypoglossum* the coccidia are seated on the midrib, and the tetraspores arranged in longitudinal linear rows like sori on each side of the midrib.

Fig. 161.



Delesseria sanguinea. Midribs of fronds in winter bearing sporophylls. Nat. size.

BIBL. Harvey, *Mar. Algæ*, 113, pl. 15 A; *Phyc. Brit.* pls. 2, 26, 83, 151, 247, 259; Greville, *Alg. Brit.* pls. 72-74, 76.

DELESSERIA'CEÆ.—A family of Florideæ. Rosy or purplish red, or blood-red sea-weeds, with a leafy, or rarely filiform, areolated, inarticulate frond, composed of polygonal cells. Lobes of the frond deli-

cately membranous. *Fructification* double; 1. *Conceptacles* (*coccidia*) external, or half-immersed, hemispherical, usually imperforate, containing beneath a membranous pericarp a tuft of dichotomous filaments, whose articulations are finally changed into spores. 2. *Tetraspores* in distinctly definite *sori*, either scattered through the frond or placed in proper fruit-lobes or *sporophylls*.

Synopsis of British Genera.

Delesseria. *Frond* leafy, of indefinite form, with a percurrent midrib.

Nitophyllum. *Frond* leafy, of definite form, without a midrib (sometimes traversed by vague, vanishing nerves).

Plocamium. *Frond* linear or filiform, compressed, much branched, distichous; ramuli pectinate, secund.

Bibl. See the genera.

DELTO'MONAS, Kent.—A genus of Flagellate Infusoria.

Char. Bodies variable, wedge-shaped, stalked; flagella two, equal. Freshwater. Multiplication by longitudinal and transverse division, and the breaking up of the body into germs. In ponds. (Kent, *Inf.* 283.)

DEMATIEI.—A family of Hyphomycetous Fungi, growing on the dead parts of plants, and characterized by the mostly septate spores being attached to rigid thick-walled filaments, which are continuous or septate.

According to the observations of Tulasne, many of the supposed genera of this family are merely conidiiferous states of Ascomycetous Fungi; for instance *Cladosporium*. We enumerate them here according to the older arrangement, as their history is not yet fully cleared up.

Synopsis of British Genera.

Cephalotrichum. Fertile filaments stalk-like, erect, septate, terminating in a globose capitule formed by radiating forked or ternate branches bearing globular spores at their tips.

Sporocybe. Filaments rather fibrous, subulate, capitate, bearing simple spores conglobated into a terminal head.

Œdemium. Filaments rigid, erect, almost continuous, or annulated, bearing at the sides globular masses of spores.

Myxotrichum. Filaments erect, scarcely septate; fertile branches crowned by globules of heterogeneous conglutinate spores.

Helminthosporium. Filaments erect, simple, septate; spores transversely septate.

Bolacotricha. Filaments simple, uniformly articulate at the apex; spores conglomerated, large, globular, shortly stalked, contents distinctly granular.

Triposporium. Filaments erect, septate, sterile branches solitary, more or less spreading; fertile branches shorter, bearing at the tips solitary, stellate, mostly very shortly stalked spores.

Helicosporium. Filaments erect, subulate, closely septate, continuous and diaphanous at the summit; spores thread-like, septate, spirally coiled, then expanding themselves with elasticity.

Cladotrichum. Filaments erect, septate, branched; branches and branchlets bearing septate spores at their tips.

Dematium. Filaments erect, septate, with verticillate branchlets below, simple and whip-like above; spores crowded on the apices of the ramules.

Cladosporium. Filaments erect, septate above, bearing the spores arranged in rows forming short moniliform branchlets.

Macrosporium. Filaments suberect, septate, delicate, evanescent, bearing erect, stipitate spores, with many transverse and usually some longitudinal septa.

Arthrinium. Filaments tufted, suberect, annulate, with opaque thickish septa; spores fusiform, septate, large.

Camptoum. Filaments as in the preceding; spores ovate, curved, small.

Arthrobotryum. Common stem composed of jointed filaments. Spores large, radiating, so as to form a little head, dark, septate.

Dendryphium. Filaments free, jointed, simple below, branched above; branches and branchlets often monilioid; spores septate, acrogenous, concatenated.

Periconia. Stem composed of fasciculated compacted filaments; head globose; spores fixed to the free tips of the filaments.

Haplographium. Filaments jointed, free, black; spores concatenate, hyaline.

Monotospora. Filaments free, black, bearing one or rarely two (by division) large, black, subglobose spores at their tips.

Helicoma. Filaments erect, dark, jointed, bearing on their sides pale, flat, spiral spores.

Polythrincium. Filaments moniliform; spores springing from the midst of the filaments, didymous.

Gonatosporium. Filaments erect, jointed,

thickened at the articulations; spores irregularly biconical, somewhat angular, attached in whorls.

Sporodum. Filaments erect, jointed; threads of inarticulate spores moniliform, seated towards their base.

Allied or uncertain Genera.

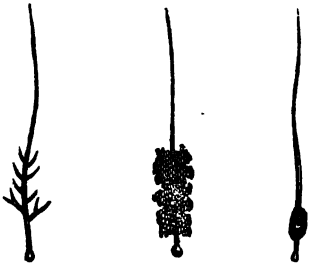
Blastotrichum. Pedicels ascending or floating, very much branched, continuous; spores oblong, transversely septate.

Stachyobotrys. Pedicels branched, septate; branches crowded at the tips with whorls of mammillary very short branchlets forming a capitulum; spores didymous.

Helicotrichum. Filaments creeping, branched, septate only at the tips; spores spirally curled, somewhat septate.

DEMA'TIUM, Pers.—A genus of Dematiei (Hyphomycetous Fungi), growing upon

Fig. 162. Fig. 163. Fig. 164.



Dematium griseum. Magnified 200 diameters.

dry leaves, bark, &c., distinguished by the sporiferous branchlets arising closely together near the base of the erect filaments. British species:

D. griseum, Pers. (figs. 162–4). On rotten hazel-stumps. *Chætopsis Wauchii*, Grev. *Sc. Crypt. Fl.* pl. 236. See ECHINOBOTRYUM.

BIBL. Berk. *Hook. Brit. Fl.* v. pt. 2, 338; *Ann. N. H.* i. 260, vi. 435; Grev. *l. c.*; Fries, *Sum. Veg.* 499; Corda, *Ic. Fung.* i. pl. 4. figs. 242, 243.

DEMO'DEX, Owen (*Simonia*, Gerv.).—A genus of Arachnida, the exact systematic position of which is doubtful, although usually placed in the family Acarina.

Char. Legs terminated by two claws (only one, Beck), no acetabula; abdomen annulose.

D. folliculorum (Pl. 6. fig. 42), the *Acarus*, *Simonia*, or *Entozoon folliculorum* of some authors, inhabits the sebaceous and hair-follicles of the human skin. The minute size of the various parts renders it extremely difficult to isolate them. It varies in length from about 1-150 to 1-50″.

At the anterior part of the body are two two-jointed organs (Pl. 6. fig. 43 *a*), the basa joint longest, the distal smallest, and terminated by a strong claw; these appear to represent maxillary palpi. Between these are two narrow elongated organs (fig. 43 *b*), the mandibles. Behind these is a triangular labrum (fig. 43 *c*); a labium has also been described.

Above or upon the basal joint of the palpi are two minute tubercles, one on each side (fig. 43 *d*). Similar tubercles are seen upon the dorsal surface of the thorax, between the second and third, and the third and fourth pairs of legs.

On each side of the thorax are four pairs of very short conical legs; these are apparently three-jointed, and marked by irregular fine transverse striæ.

The abdomen is longer than the thorax, tapers posteriorly, and exhibits indications of transverse rings, in the form of numerous delicate transverse lines.

These animals may be obtained by pressing out the contents of the follicles existing upon the sides and alæ of the nose, especially when these appear enlarged, whitish, and exhibit a terminal black spot. A drop of oil should then be added to the secretion, and the whole allowed to macerate for some hours at a gentle heat. Or the secretion may be digested in a mixture of alcohol and ether, to dissolve the fatty matter, and then treated with solution of potash.

The secretion contains the ova, the young animals, and the exuviæ. When contained in the follicles, the tail is directed towards their orifice.

Var. *caninus* occurs in the pustules of the skin of the dog affected with the "mange." The average size of this is less than that of *D. folliculorum*, amounting to 1-150 to 1-100″ in length. It does not appear to constitute a distinct species; for Gruby found that, by inoculating the dog with the human parasite, a disease resembling, if not identical with, the mange was produced.

Var. *cati*, on the cat; about ¼ less than *D. folliculorum*.

BIBL. Simon, *Müller's Archiv*, 1842, 218; Owen, *Hunt. Lect.* i. 251; Gervais, *Walckenaër's Aptères*, iii. 282; Wilson, *Tr. Roy. Soc.* 1844, 305; Tulk, *Ann. N. H.* 1844, xiii. 75; Gruby, *Ed. Mn. Jn.* vii. 333;

Wedl, *Path. Hist.* 803; R. Beck, *Achr. Micr.* 6, pl. 24. fig. 1; Mégnin, *Parasites*, 265

DENDRITI'NA, D'Orb.—The nautiloid, or compactly discoidal, condition of *Peneroplis*. Common in tropical seas.

Bibl. Carpenter, *Introd. For.* 88.

DENDROCOME'TES, Stein.—A doubtful genus of Acinetina. The single species, *D. paradoxus* (Pl. 32. fig. 36), is supposed by Stein to constitute the resting stage or *Acineta* form of *Spirochona gemmipara*. It is found upon the gill-plates of *Gammarus pulex*.

Bibl. Stein, *Siebold & Kölliker's Zeitschr.* 1852, iii. 492; id. *Infus.* 205; Kent, *Inf.*

DENDRO'MONAS, Stein.—A genus of Flagellate Infusoria.

Char. Bodies pyriform, obliquely truncate, single at the ends of a rigid homogeneous branched pedicle; flagella two; one long, and the other short, lateral. Freshwater. 2 species. (Kent, *Inf.* 265).

DENDROSO'MA, Ehr.—A genus of Rhizopoda, of the family Acinetina.

Char. Consists of a thick branched pedicle, fixed at its base, the branches supporting at their ends numerous bodies, a little larger than the pedicles, each resembling an *Actinophrys*.

D. radians. Bodies conical, thick, soft and smooth, alternately branched; branches incrassate and tentaculate at the ends. Size 1-96''. Freshwater.

Bibl. Ehrenberg, *Infus.* 316; Cl. & Lachm. *Inf.* iii. 140 (fig.).

DENDRYPHIUM, Wallr.—A genus of Dematiei (Hyphomycetous Fungi), consisting of moulds growing over dead herbaceous plants, nearly related to *Dactylium*; but there are often several spores chained together at the tips of the branches; perhaps not distinct from *Brachycladium*, Corda, whose species of *Dactylium* (fig. 165) are brought under this genus by Fries. British species:

Fig. 165.

Dendryphium fumosum. Magn. 200 diams.

D. curtum, Berk. and Br. On dead stems. *Ann. N. H.* 1851, vii. pl. 6. fig. 9.

D. laxum, Berk. and Br. On dead stems. *L. c.* fig. 10.

D. griseum, Berk. and Br. On dead stems. *L. c.* fig. 11.

Bibl. Berkeley and Broome, *l. c.* 176, pl. 6; Fries, *Summa Veget.* 504.

DENTALI'NA, D'Orbigny.—The bent, oblique, and somewhat excentric varieties of *Nodosaria* pass under this name for convenience rather than for zoological reasons. Innumerable modifications of these curved and tapering stichostegian Foraminifera occur in all formations from the Carboniferous to the Tertiary, and abound in existing seas. *D. communis*, D'Orb. (Pl. 23. f. 33) is the type, and has persisted the longest of any.

Bibl. D'Orb. *For. Foss. Vien.* 1846; Williamson, *Rec. For.* 17; Morris, *Brit. Foss.* 34; Carpenter, *Foram.* 163; Jones, Parker, and Brady, *Monog. Foram. Crag, Pal. Soc.* 1866, 53, &c.

DENTALINOP'SIS, Reuss.—A stichostegian *Nodosarina*, commencing in its growth as a *Rhabdogonium* (*Orthocerina*), and continuing as a *Dentalina*. Only fossil; Cretaceous.

Bibl. Reuss, *Sitz. Ak. Wien*, xliv. 367.

DENTICEL'LA, Ehr. See Biddulphia.

DENTIC'ULA, Kütz.—A genus of Diatomaceæ.

Char. Frustules free, single or binate, straight, oblong or linear in front view; valves elliptical or narrowed at the ends, transversely striated. Freshwater.

Striæ mostly coarse, not resolvable into dots (costæ); valves without a median line or nodules; ends of the striæ visible at the margins of the front view of the frustules; no internal septa.

Five British species. Seven European species; one fossil (California).

D. obtusa (Pl. 16. fig. 25: *d*, front view; *c*, valve). Valves lanceolate, attenuate and obtuse at the end; length 1-330''.

The other species differ principally in size; *D. sinuata* is undulate in side view.

Bibl. Kützing, *Sp. Alg.* 11; Smith, *Br. Diat.* ii. 19; Rabenhorst, *Fl. Alg.* i. 114.

DEPA'RIA, Hook.—A genus of Dicksoniæous Ferns, with stalked indusia, shaped like ancient flat goblets (fig. 166, p. 242). Five very rare tropical species.

Bibl. Hooker, *Syn.* 56.

DEPA'ZEA, Fries. See Sphæria.

DEPOSITS, URINARY. See Urine.

DERMALEI'CHUS, Koch = Analges (Murray, *Econ. Ent.* 327).

DERMANYS'SUS, Dugès.—A genus of Arachnida, of the order Acarina, and family Gamasea.

Char. Body mostly soft; palpi, the fifth

Fig. 166.

Deparia prolifera.
Sorus enclosed in the stalked indusium.
Magnified 25 diameters.

(last) joint smallest; labium acute; mandibles of the male chelate, external claw very long; of the female, ensiform; anterior legs longest; coxæ approximate.

D. avium (Pl. 6. fig. 24). Found in the cages of tame singing birds and upon poultry. Body ovate-oblong, depressed, slightly broader and sometimes emarginate posteriorly. The sixth joint of the legs (*c*) is the longest. Mouth forming a kind of moveable head attached to the under part of the anterior margin of the body; it consists of:—1, a triangular labium, pointed in front, and with two palpi (fig. 24 *a**), the second joint largest, the fifth smallest and accompanied by a large but short, moveable, external seta; and, 3, the two mandibles (*b*, of female; *a*† of male). Red or reddish brown.

This species sometimes infests human beings, producing a skin-disease, being derived from fowls.

D. vespertilionis. Found upon the mouse-coloured bat (*V. murinus*). Rostrum nearly as long as the palpi, broad or oval at the base, narrowed in front, cleft longitudinally above, and containing the two long and slender mandibles.

D. pipistrelli. On the common bat (*V. pipistrellus*).

D. hirundinis. In the nest of the swallow.

D. gallinæ. On the common fowl.

D. Nitzschii. In the nostrils of the goat-sucker (*Caprimulgus*).

Other species are found on the noctule bat (*V. noctula*), the merlin, the turkey, the snail, the mouse, serpents, &c.; and two on the pæony and the convolvulus.

Bibl. Dugès, *Ann. Sc. Nat.* 2 sér. ii. 19; Gervais, *Walckenaer's Arach.* iii. 222; Busk, *Mic. Jn.* 1842, ii. 65; Kolenati, *Sitz. Ak. Wien*, 1859, 172; *Murray, Ec. Ent.* 169; Mégnin, *Paras.* 1880, 115.

DERMATIS'CUM, Nyl.—A genus of Lichens, tribe Lecanorei, formed to contain *Endocarpon Thunbergii*, a native of the Cape of Good Hope.

Bibl. Nylander, *Enum. Gen.* 116.

DERMATODEC'TES = Sarcoptes.

DERMES'TES, Linn.—A genus of Dermestidæ.

DERMES'TIDÆ.—A family of Coleopterous Insects.

The larvæ of these insects, which are often minute, create great ravages amongst dried skins, furs, &c.; they also feed upon feathers, bacon, books, paper, insects in cabinets, mummies, &c. They are particularly interesting to the microscopist, on account of the peculiar and beautiful structure of certain of the hairs (Pl. 1. fig. 1, *a*, *b*) existing upon their bodies.

The hairs form three distinct tufts on each side of the hinder segments of the bodies of the larvæ. The ordinary finely spinous hairs on the rest of the body are shown in *c*.

Although these hairs are generally called the hairs of *Dermestes*, it so happens that this genus is almost the only one in the species of which the hairs do not exist.

British gen.: *Anthrenus, Attagenus, Megatoma, Tiresias, Dermestes,* and *Trinodes.*

Bibl. Westwood, *Introd.* i.; Curtis, *Br. Insects*, 682; Stephens, *Manual*, 142.

DESMAREL'LA, Kent.—A genus of Infusoria.

Char. Free, united laterally into rows; flagellum single, terminal, encircled at the base by a collar. 2 species, 1 in fresh, the the other in salt water; length of bodies $\frac{1}{1000}$". (Kent, *Inf.* 341.)

DESMARES'TIA, Lamx.—A genus of Sporochnaceæ (Fucoid Algæ), consisting of olive or brownish seaweeds, with repeatedly pinnate, feathery fronds, from one to several feet long, growing chiefly between tide-marks or in deep water. The characters of the reproductive structures have not yet been made out, as the species rarely fruit on our coast, although the plants are common.

Bibl. Harvey, *Mar. Alg.* 23, pl. 5 D; *Phyc. Brit.* 49, 115; Greville, *Alg. Brit.* pl. 5. figs. 1 to 6.

DESMIDIA'CEÆ (Pl. 14).—A family of Confervoid Algæ, consisting entirely of microscopic flexible organisms inhabiting fresh

water, scarcely a specimen of which can be found that does not contain some of them. They occur in greatest abundance in clear pools in open exposed situations, the larger species being generally found nearest the bottom. Sometimes they adhere in large numbers to aquatic plants, forming green films investing them; at others they rest as a thick coating at the bottom of the water, or lie intermingled with Confervæ, &c.

They are most striking objects under the microscope, from the peculiarity, beauty, and variety of their forms, their colour, and their external markings and appendages; that which is most distinctive in their appearance is the bilateral symmetry, indicative of the tendency to divide transversely into two valves or segments. Each frustule is in reality a single cell, as is shown by the fact that the entire contents escape when an orifice is made; but in the generality of the forms, a constriction, or more or less deep notch, or a kind of suture exists in the middle of the external cellulose coat. In a few instances, such as *Scenedesmus*, the symmetrical form is absent; in *Pediastrum* (Pl. 14. figs. 48, 49) it is only indicated by a notch on the outer side; but a graduated series may be formed, from those genera in which this character is inconspicuous, to those in which it is fully developed. Thus in *Closterium* (figs. 40 to 45) and some species of *Penium*, there is no constriction; in *Tetmemorus* (fig. 33), some *Cosmaria* (fig. 22), and *Hyalotheca* (fig. 1), it is quite evident, although but slight; in *Didymoprium* and *Desmidium* (fig. 7), it is denoted by a notch at each angle; while in *Sphærozosma*, *Micrasterias* (fig. 13), and some other genera, the constriction is very deep, the connecting portion forming a mere isthmus between the segments, which appear like distinct cells.

The cells frequently exhibit external warty or spinous processes (Pl. 14. fig. 23), and the cellulose coat (coloured blue by means of iodine and sulphuric acid) presents minute markings which, unlike those on the siliceous envelope of the Diatomaceæ, are always elevations. The cells are surrounded by a more or less perfect and distinct sheath, of gelatinous consistence, and very transparent. In *Hyalotheca*, *Didymoprium*, *Sphærozosma*, &c., this is very well defined (Pl. 14. figs. 1 to 6); but in other genera it is more attenuated, and the fact of its existence can only be discovered by its preventing the contact of the cells. The sheath of *Hyalotheca* often presents delicate dark striæ, which, if the gelatinous sheath is not clearly seen, look like rigid cilia standing upon the surface of the cell-wall; these appear to be either fissures in the gelatinous sheath, connected with the breaking up of the filamentous groups into single cells, or they are referable to a fibrous disintegration of the gelatinous sheaths, such as occurs in many OSCILLATORIACEÆ.

The contents of the cells of the Desmidiaceæ appear to resemble those of the green Confervoids generally, in consisting of a mass of protoplasm coloured green by chlorophyll, and being entirely enclosed in a primordial utricle, which does not appear to be adherent to the cellulose coat in mature specimens. The contents of the cells contain minute starch-granules as in the other Confervoids, in the full-grown condition, and in the zygospores.

It was stated some years ago by Focke, that the internal surface of the outer coat of *Closterium* is ciliated; and Osborne has declared that the membrane of the endochrome (primordial utricle) is ciliated both on its inner and outer surface. These statements are erroneous, as is shown under CLOSTERIUM.

The Desmidiaceæ, at all events many of them, have the power of fixing themselves to external objects, and possess a feeble power of locomotion, which is not produced by the aid of cilia, and cannot be explained, unless on the principles which have been assumed to account for the same phenomenon in the DIATOMACEÆ. It enables the Desmidiaceæ, when mixed with mud, to make their way to the surface; and they will be found to travel and fix themselves to that side of a glass vessel next the light. In some instances, also, they retire beneath the surface of the mud of pools &c. before this dries up.

The Desmidiaceæ, like other green plants, evolve oxygen when exposed to the sun's light.

The reproduction of this family exhibits a number of very interesting and varied phenomena. Four modes have been observed; and some points connected with the subject still remain to be cleared up.

The simplest kind of reproduction is by cell-division, where each frustule divides transversely into two. The manner in which this takes place differs to some extent in its details in the various genera, according to the form. Thus in *Closterium*

the parent-cell acquires a constricted appearance in the middle, probably not by actual constriction, but by the two halves retreating from each other, while a new hour-glass-shaped prolongation of the membrane is formed in the middle. It appears probable also that the primordial utricle first becomes constricted, since specimens are met with in which this appears divided into two portions in the line of the division. The constriction of the outer cell-wall at length becomes complete the halves separate and the truncate new end of each then grows out so as to restore the symmetry of the new frustule. In such forms as *Desmidium*, *Didymoprium*, &c., the division takes place in a manner apparently resembling that occurring in the filamentous Confervæ. Here there is no necessity for the subsequent restoration of symmetry, as in *Closterium*. In those forms where pairs of globular or elliptical or angular lobes are united by a narrow neck (bipartite forms), the process of division is very curious, and displays itself very clearly. To produce two new symmetrical frustules out of one, it is evident that two new half-frustules must be formed, as in *Closterium*; but in the present cases the foundations of the new halves are laid, and their development often far advanced, before the division of the parent is completed. The central region of the isthmus expands and displays two globular enlargements, separated from each other, and from each half of the parent, by a neck. These two enlargements are the rudiments of the new 'half-frustules;' and they increase in size (Pl. 14. fig. 11), gradually pushing the halves of the parent-cell apart, until they form two complete half-frustules, back to back, connected by a short neck, at which point they are sooner or later detached from one another. In *Sphærozosma* the cells thus produced remain connected in rows in a gelatinous sheath; and this mode of division is well illustrated by the cells in various stages sometimes seen in such filaments; in *Euastrum*, *Cosmarium*, *Staurastrum*, &c., the new cells separate, the old half-frustules taking away each their new halves as new bipartite individuals. The membrane of the nascent halves is very delicate, and at first devoid of the characteristic markings and processes; and it often happens that these are not completely formed before the division is complete. Archer has described some monstrosities of these new halves.

A second mode of reproduction has been described by Caspary and Braun, in *Pediastrum*. The contents of the parent-cells become retracted from their walls, and the whole transformed into a number of active *ciliated zoospores*, which are discharged within a delicate sac from the parent, and after some time come to rest and arrange themselves within this sac (Pl. 10. fig. 11) into a colony having the regular pattern of the species, each zoospore becoming one of the notched frustules of the group (see PEDIASTRUM).

A third process, analogous to this, has been observed by Pringsheim in the genus *Cœlastrum*, likewise composed of grouped families: here the contents of each cell are divided into a number of portions, as if for the formation of zoospores (*still zoospores*), but no motion takes place; they acquire cellulose coats, arrange themselves within the parent according to the typical pattern; and then the wall of the parent-cell splits and peels off, leaving them as the foundation of a new group. Connected with this, is a phenomenon which has been observed and figured in *Closterium*, by Focke, where the entire green contents were only retracted from the walls, and broken up into a number of green encysted globules (Pl. 10. fig. 3B), closely resembling the thick-walled resting-spores or winter-spores of *Volvox* (Pl. 7. figs. 26, 34), &c.

The fourth mode of reproduction is by what is called *Conjugation*, where two cells of a single filament, or of two separate filaments, contract an organic union, their cavities becoming continuous, and their contents becoming blended to form the substance of a zygospore. These are at first cellulose vesicles filled with green and granular contents, their starch being converted into fat; by degrees they become brown or red, and the coats become thickened. In some genera the coats remain smooth; in others they acquire a granular, tuberculated or even a spinous surface (Pl. 14. fig. 12), these spines being either simple or forked. Bodies exactly resembling these are found fossil in flint, and are regarded as of the same nature by Ralfs and others; Ehrenberg described them as species of XANTHIDIUM. In germination, the contents of the zygospore escape as a thin-walled vesicle, and become divided into a more or less numerous brood of secondary cells, resembling those of the parents (Pl. 10. fig. 3 A *d*.).

The Desmidiaceæ may be collected in the same manner as is recommended for the

Diatomaceæ. Their preservation is a difficult matter, as almost all the preservative liquids alter them more or less. Those producing the smallest amount of change are Thwaites's liquid, Ralfs's liquid, or simple camphor-water; but these liquids always escape in time from the cells. A few, for example *Pediastrum*, are unchanged by concentrated solution of chloride of calcium very gradually added, except that the colour becomes rather paler, or solution of acetate of potash; moreover the cell-membrane, upon the forms of which the characters mainly depend, remains unaltered in all the kinds when kept in these solutions. Many prefer glycerine, which is really the best preservative medium; in some cases glycerine-jelly is used.

See Preservation.

Analysis of the Tribes and Genera. (Pl. 14.)

I. Closterieæ. Cells single, elongated, never spinous, frequently not constricted in the middle (sporangia smooth).

Closterium. Cell crescent-shaped or arcuate, or much attenuated at the ends, not constricted in the middle (figs. 40–45, 57, 58).

Penium. Cell straight, not or very slightly constricted in the middle, rounded at the ends (fig. 36).

Tetmemorus. Cell straight, constricted i the middle, notched at the ends (figs. 33, 34).

Docidium. Cell straight, constricted in the middle, truncate at the ends (figs. 38, 39).

Spirotænia. Cell straight, not constricted; endochrome spiral (fig. 59).

II. Cosmarieæ. Cells single, distinctly constricted in the middle; segments seldom longer than broad (sporangia spinous or tuberculated).

Micrasterias. Lobes of the segments incised or bidentate (fig. 13).

Euastrum. Segments sinuated, generally notched at the ends, and with inflated protuberances (figs. 14 to 17).

Cosmarium. Segments neither notched nor sinuated, end view elliptic, circular, or cruciform (figs. 18 to 22).

Xanthidium. Segments compressed, entire, spinous (figs. 23 to 25).

Arthrodesmus. Segments compressed, each with only two spines (fig. 27).

Staurastrum. End view angular, radiate, or with elongated processes (figs. 26, 28–32, and 56).

III. Desmidieæ. Cells united into an elongated jointed filament (sporangia spherical, smooth).

Genicularia. Filament cylindrical, smooth; endochrome spiral (Pl. 51. fig. 36).

Gonatozygon. Filament cylindrical or fusiform, smooth; endochrome longitudinal, wavy (Pl. 51. fig. 37).

Hyalotheca. Filament cylindrical, cells crenate (Pl. 14. figs. 1, 2).

Didymoprium. Filament cylindrical or subcylindrical; cells with two opposite bidentate projections (figs. 5, 6).

Desmidium. Filament triangular or quadrangular; cells with two opposite bidentate projections (figs. 7, 8).

Aptogonum. Filament triangular or plane, with foramina between the joints (figs. 52, 55).

Sphærozosma. Filament plane, margins deeply incised or sinuated (figs. 9, 10).

IV. Ankistrodesmieæ. Cells elongated, entire, small, grouped in faggot-like bundles. *Ankistrodesmus* (fig. 47).

V. Pediastreæ. Cells grouped in the form of a disk or star, or placed side by side in one or two short rows.

Pediastrum. Cells forming a disk or star, marginal cells bidentate (fig. 48).

Monactinus. Cells as in *Pediastrum*, but marginal cells unidentate (Pl. 36. fig. 28).

Scenedesmus. Cells placed side by side in one or two rows (figs. 50, 51, 53, 54).

Cœlastrum. Cells forming a hollow sphere (Pl. 3. fig. 8).

Three interesting genera are described and figured by Wallich from Lower Bengal (*Lewronema*, *Onychonema*, and *Streptonema*).

Tetrachastrum, Archer = *Micrasterias*, pt.; *Triploceras* = *Docidium*, pt.; *Leptocystinema*, Arch. = *Gonatozygon*, De Bary; *Spondylosium* = *Sphærozosma*, pt.

Rabenhorst places *Cosmocladium* among the Palmellaceæ.

Bibl. Ralfs, *Br. Desmid.*; Ehrenberg, *Inf.*; Pritchard, *Infus.*; Hassall, *Algæ*; Nägeli, *Einzell. Alg.* 1849; Braun, *Verjüng.* (*Ray Soc.* 1853); Focke, *Phys. Studien*, 1848; Caspary, *Bot. Zeit.* viii. 786, 1850; Pringsheim, *Flora*, 1852, 486; Hofmeister, *Ann. N. H.* 3 ser. i. 1; Carter, *ibid.* 2 ser. xvii.; Thomas, *Mic. Tr.* 3 ser.; Bailey *Smiths. Contr.* 1854; Rabenhorst, *Fl. Alg.* iii. 102; Wallich, *Ann. N. H.* 1860, v. 184, 273; Archer, *Qu. M. Jn.* 1860, viii. 85, 215, 235; Brébisson, *Liste*, 1856, 2 plates;

Sachs, *Bot.* 262; Notaris, *Desmidiacee Italiche*, 1867; Delaporte, *Desm. subalp.* 1877 (23 pls.).

DESMID'IUM, Ag.—A genus of Desmidiaceæ.

Char. Cells united into a brittle, regularly twisted, triangular or quadrangular filament, and two-toothed at the angles.

The filaments exhibit one or two dark, oblique, wavy lines, arising from their being twisted. In the side view of the cells, the endochrome exhibits thick, frequently cleft rays, corresponding in number with the angles.

D. Swartzii (Pl. 14. fig. 7; fig. 8, side view of separate cell). Filament triangular. Length of joint 1-2000 to 1-1660″; breadth of filament 1-630″. Not uncommon. Sporangia round or oblong.

D. quadrangulatum. Filaments quadrangular. Length of joint 1-2400″; breadth of filament 1-600 to 1-450″.

Bibl. Ralfs, *Br. Desmid.* 60; Kützing, *Sp. Alg.* 190.

DESMOGONIUM, Ehr.—A genus of Diatomaceæ.

Char. Frustules those of *Synedra* united into tablets, which are coherent by the angles.

D. Kützingii. Submarine marshes; Germany.

D. Gujanense. Found in Asia, Africa, and America.

Bibl. Ehrenberg, *Mikrog.*; Rabenhorst, *Flor. Alg.* i. 142.

DEUTZ'IA, Thunberg.—A genus of Philadelphaceæ (Dicotyledonous Plants) remarkable for the stellate hairs upon their foliage (Pl. 28. fig. 26*), and the reticulated membrane covering the seeds; both of which structures form interesting microscopic objects. See Hairs and Seeds.

Fig. 167.

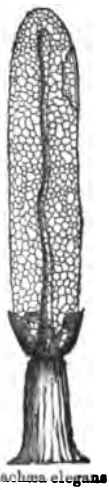
Diacalpe asplenioides. Part of a pinnule with sori. Magnified 10 diams.

DIACAL'PE, Bl.—A genus of Cyatheæ (Polypodiaceous Ferns), with globular indusia, splitting open at the top (fig. 167), and containing sporanges inserted on a punctiform receptacle rising from the middle of the vein. Herbaceous; leaves tripinnate, membranous. Native of Java, &c.

Bibl. Hooker, *Syn.* 45.

DIACHÆ'A, Fries.—A genus of Myxomycetes, consisting of perishable little plants, growing over either living or dead plants, with an elongated membranous peridium, which falls off like a cap, and displays a white reticulated capillitium furnished with a floccose central column, with interspersed blackish-red spores.

Fig. 168.



Diachæa elegans; Magn. 25 diams.

Diachæa differs from *Stemonitis* in the peridium, the columella, and the habit of growth.

D. elegans, Fr. (*Stemonitis*, Trentep.), the only species, has been found in England, upon the living leaves of the Lily of the Valley &c. (fig. 168).

Bibl. Fries, *Syst. Mycol.* iii. 155; Berk. *Ann. N. H.* i. 257; Corda, *Ic. Fung.* v. pl. 3. fig. 38.

DIADES'MIS, Kütz.—A genus of Diatomaceæ (Cohort Naviculeæ).

Char. Frustules navicular, closely united into elongated biconvex filaments; valves with a median and terminal nodules. Freshwater and marine.

The markings have not been satisfactorily investigated.

D. confervacea (Pl. 16. fig. 27). Breadth of frustules (in front view) about half the length; valves lanceolate, acuminate and acute at the ends; length of frustules 1-960″.

Eight species, some fossil.

Bibl. Kützing, *Sp. Alg.* 95; Rabenhorst, *Flor. Alg.* i. 259.

DIAMOND-BEETLE. See Curculio.

DIAP'TOMUS, Westw.—A genus of Entomostraca, of the order Copepoda, and family Diaptomidæ.

Char. Head distinct from thorax; inferior antennæ two-branched; thorax and abdomen each of five segments; foot-jaws unbranched; legs five pairs, the first pair with two branches, one three- the other two-jointed; three succeeding pairs with each branch three-jointed; external ovary single, large, lying across the abdomen.

D. castor (Pl. 20. fig. 38). Found in ponds and slowly-running water; common in spring and autumn. Length about 1-8″.

Bibl. Westwood, *Entom. Text-book*; Baird, *Br. Entom*; M.-Edwards, *Crust.* iii. 427.

DIAS, Lillj.—A genus of Copepoda (Entomostraca).

D. longiremis. Cumberland.

Bibl. Brady, *Copepoda* (*Ray Soc.*) i. 50.

DIASTO'PORA, Lamouroux.—A genus of Infundibulate Polyzoa, of the suborder Cyclostomata, and family Tubuliporidæ.

Distinguished by the incrusting, undefined or foliaceous zoary; and the alternate, tubular, horizontal, immersed cells, with a raised circular orifice.

D. obelia. Crust thin, closely adnate. Three other species.

Bibl. Johnston, *Br. Zooph.* 276; Gosse, *Mar. Zool.* ii. 8; Hincks, *Polyzoa*, 457.

DIA'TOMA, Dec.—A genus of Diatomaceæ (Cohort Fragilariæ).

Char. Frustules (in front view) linear, sometimes cuneate; at first united into flat filaments, afterwards partly separating so as to remain connected by the generally alternate angles only, and thus forming a zigzag chain.

Filaments either free or fixed by a stipes. Frustules prismatic, without vittæ; valves with transverse continuous striæ (costæ) and intermediate finer striæ, not always visible by direct light; ends of the striæ extending into the front view.

Five British species:

D. vulgare (Pl. 16. fig. 26: *a*, side view; *b*, front view). Fixed by an inconspicuous stipes; frustules rectangular, oblong; valves elliptical, contracted and obtuse at the ends; striæ evident; length of frustules 1-430″. Freshwater.

D. elongatum. Frustules very slender, slightly attenuated towards the middle; valves linear, evidently striated, tumid and rounded at the ends; length 1-260″. Freshwater.

D. grande. Valves linear, constricted near the rounded ends; costæ evident. Freshwater.

D. hyalinum. Filament of numerous frustules; valves linear-elliptical, ends subacute, striæ obscure. Marine.

D. minimum. Frustules two or three; valves elliptical, ends rounded; striæ obscure. Marine.

Bibl. Ralfs, *Ann. N. H.* 1843, xi. 449; Kützing, *Bac. & Sp. Alg.* 16; Smith, *Br. Diat.* ii. 38; Rabenhorst, *Fl. Alg.* i.

DIATOMA'CEÆ.—A family of Confervoid Algæ, of very peculiar character, consisting of microscopic brittle organisms, found in almost all fresh, brackish, or salt water; sometimes forming a uniform yellowish-brown layer on the bottom of the water, at others adhering to various waterplants, decaying stems, stones, &c., or scattered between the filaments of Confervæ and marine Algæ &c. They also occur among Mosses, *Oscillatoriæ*, and on damp ground.

The individual cells of the Diatomaceæ are called frustules or testules, and are furnished with a coat of silica (Cytioderm). This consists of two usually symmetrical portions or valves comparable to those of a bivalve shell, which are in contact at their margins with an intermediate piece (the hoop), variable in breadth, according to age &c. When this is very narrow, it forms a mere junction line, and is called the line of suture; and that aspect of the frustules in which this is turned towards the observer forms the front or front view: primary side, Kützing; secondary side, Rabenh. (Pl. 15. fig. 7; Pl. 16. figs. 9 *a*, 30 *b*). That aspect of the frustules in which the surface of the valves is turned towards the observer, forms the side or side-view of the frustules: secondary side; Kützing, primary side, Rabenh. (Pl. 15. fig. 6; Pl. 16. fig. 30 *a*).

The separate valves are of various forms: circular, oblong, elliptical, linear, saddle-shaped, boat-shaped (navicular), undulate, sigmoid, &c. (Pls. 15, 16, 17); and their surfaces exhibit various more or less delicate sculpturings and markings, in the form of bands, lines either parallel, radiate, or crossing each other, and dots, or a cellular (areolate) appearance.

These markings are in general not well seen, and in some cases cannot be seen at all, until the valves have been properly prepared. They are of special interest, not only on account of their extremely beautiful delicacy and symmetry, but because they are used as tests for the quality of the object-glasses in regard to angular aperture. The nature of the markings is described under the individual genera; and the modes of viewing them will be spoken of further on.

In some the hoop is a simple filament, so curved or bent as to assume the form of the section of the frustules, or the edges of the valves (Pl. 15. fig. 11). In others, it is broad, and marked like the surfaces of the valves (Pl. 17. fig. 2 *a*). In others, again, the hoops are numerous, flat, and arranged like the leaves of a book, each with a round or oval aperture in the middle, so that the cavity of the frustules is divided into loculi;

these frustules we shall distinguish as compound (Pl. 18. fig. 69).

During the process of multiplication by division, which is almost always going on, the annular siliceous, narrower or broader band, or hoop, undergoes an increase of width, and the two valves are removed some distance apart (Pl. 15. figs. 7, 45; Pl. 16. fig. 1). Sometimes it consists of two pieces, one overlapping the other. Some of the valves are furnished with processes, called cornua or tubuli (Pl. 16. fig. 30 *b*); the surfaces of others are undulate, producing the appearance of dark curved or wavy lines or bands (Pl. 16. figs. 22, 23, 24); sometimes curiously arranged lines, (vittæ) indicate either imperfect internal septa, the internal margins of the flattened hoops, or certain inflections of the margins of the valves (Pl. 1. figs. 14, 15; Pl. 17. figs. 17, 18).

In the young state of these organisms, the endochrome or cytioplasm is uniformly distributed; but after a certain time, it becomes accumulated into various, usually very regular and often elegant forms, and minute granular globules are formed, transparent vesicles become visible, drops of oil, and vesicles filled with granules, which at first are motionless, but afterwards move about as in the swarming motion of the Algæ. Frequently a considerable nucleus-like body is present in the middle of the frustule (Pl. 15. fig. 33 *a*). As we have seen it, delicate processes were visible arising from it.

The frustules of the Diatomaceæ are sometimes surrounded by a transparent gelatinous sheath, frequently of great delicacy, or contained in gelatinous simple or branched tubes; in some genera they are attached by a stipes or stalk to water-plants &c.

Those Diatomaceæ which are not fixed by a stipes, and especially such as are linear or spindle-shaped, are capable of spontaneous motion; they may be constantly seen slowly moving across the field, or now and then starting somewhat suddenly forwards, moving mostly in the direction of their length, sometimes receding, sometimes performing a rotatory movement on their axis. Those which are contained in numbers in gelatinous tubes, like *Encyonema* (Pl. 19. fig. 10), are capable of moving backwards and forwards in these; and Thwaites described a curious movement of the frustules of *Bacillaria paradoxa*, where the frustules, united in a band, slid backwards and forwards over one another.

The cause of this motion is undetermined. It has been supposed to be produced by the endosmotic changes connected with the nutrition of the organisms; but this is very improbable, otherwise it would be met with frequently in other minute unicellular organisms; moreover, the diffusion-movements are far too slow and gentle to explain them. No true vibratile cilia have been detected upon the Diatomaceæ, although Thwaites imagined, from the appearance of currents in the water, that they exist on *Bacillaria*. Some are not unfrequently found bearing tufts of or fringed with rigid cilia, like those often seen at the ends of the filaments of *Oscillatoriæ*; these would seem to be formed like the fringes met with in the Desmidiaceæ, by a modification of the gelatinous envelope; they never exhibit motion.

It has more recently been supposed to arise from the action of a delicate layer of protoplasm investing the frustules, or protruding through chinks between the valves of the frustules at the suture. (H. L. Smith, *Jn. Mic. Soc.* i. 1878-79.)

In placing the Diatomaceæ among plants, we assume an agreement between the frustule of a Diatomacean and an individual cell of any undoubted vegetable, such as *Protococcus*; and between the series of frustules such as we find in *Fragilaria* (Pl. 16. fig. 33), or *Melosira* (Pl. 17. fig. 5 *a*), and the cellular filament of a *Conferva* or a *Zygnema*. This agreement does undoubtedly exist; and the siliceous shell is really only a result of the incrustation or permeation by silica of a true vegetable cell-membrane, just in the same way as takes place in the epidermis of *Equisetum*. It is not yet ascertained in either case whether the silica is outside or in the substance of the cell-membrane; certainly it is not inside, as that would be incompatible with the known phenomena of division. It may be removed by hydrofluoric acid, leaving the basement membrane *in situ*; but this proves nothing. The probabilities are that the substance of the membrane is imbued with it.

In regard to the cell-contents of the Diatomaceæ, there exists a layer of protoplasm forming a primordial utricle, inside the cell-membrane, and enclosing the rest of the contents. In the coloured substance constituting the mass of the endochrome the chlorophyll is obscured by a yellow colouring-matter, diatomine or phycoxanthine; it takes a green or greenish-blue tint with

sulphuric acid, and also often by drying; and H. L. Smith has shown that it exhibits the spectroscopic reactions of chlorophyll. Oil-globules, soluble in ether, are also found, sometimes of large size, in particular stages of growth, probably representing here the starch-grains found in other Confervoids, or indeed the oil which occurs in them and other plants in seasons of rest. No starch has been detected in this family. A transparent rounded nuclear body is often observed in the centre of the contents. Schmidt found in *Frusculia salina*, after removing the oil by ether and the protoplasm by potash, a substance identical in composition with the cellulose of Lichens. This was probably derived from the organic matter of the silicified membranes of the frustules.

The ordinary mode of increase of the cells of the Diatomaceæ is, like that of all other vegetable cells, a process of division. In *Melosira*, *Isthmia*, &c. this bears a close resemblance to the process which occurs in *Spirogyra*; and it is only a modified form of the same process that is found in the free Diatomaceæ. It may be briefly described thus:—the primordial utricle, enclosing the contents, divides into two portions, which separate from one another in a plane parallel with the sides of the individual frustules; the two valves of the parent-cell gradually separate from one another, remaining connected by the simultaneous gradual widening of the hoop. In the space thus afforded, the two segments of contents secrete each a new layer of very delicate, easily crumpled membrane without markings, which ultimately becomes silicified over the surfaces, constituting two new half-frustules, back to back, corresponding to and conjoined with the two half-frustules of the parent to form two new individuals. The markings on the new valves are sometimes different from those upon the parent. The history and ultimate fate of the hoop seems to be variable. Sometimes it becomes solidly silicified, but not much expanded in breadth, and falls off when the two frustules are complete, allowing them to separate; this is the case in *Pleurosigma*, and probably in all the allied forms; these hoops are often to be found in large numbers in the settlings of water in which Diatomaceæ have been kept a long time. Perhaps the most remarkable development of the silicified hoop occurs in *Biddulphia* (Pl. 19. fig. 9), *Isthmia*, and similar forms: the new half-frustules formed inside the hoop of these genera slip out from it like the inner tubes from the outer case of a telescope. In *Melosira* (Pl. 10. fig. 8) the hoops appear to keep the new frustules united together for some time; and here there is no overlapping.

The development of the stipes to which the frustules of many genera are attached, is obscure; Cox suggests that in *Isthmia*, a separate internal cell exists, near the point at which the frustule is attached, having the office of secreting the gelatinous substance of the stipes.

The only mode of reproduction, besides the division, known certainly to exist in the Diatomaceæ, is that in which *conjugation* takes place. This has been observed in a number of genera, and presents considerable variation in its details. In *Fragilaria* (Pl. 10. fig. 4) and *Surirella* (Pl. 10. fig. 5) the conjugation takes place between two free frustules lying near together, each of which opens at the suture and extrudes its contents in a mass (probably enclosed in the primordial utricle); the masses of contents coalesce, the whole meanwhile becoming involved in a mass of gelatinous substance. After a while, the body resulting from the conjugation is seen to assume the form of a frustule, of larger size than the parents, which Thwaites, the discoverer, called a *sporangial frustule*. In the majority of cases, however, as in *Eunotia* (Pl. 10. fig. 6), *Gomphonema Cocconema*, &c., the conjugation is double, as is the case in *Closterium lineatum* (CONJUGATION); the contents of the parent-frustules apparently divide into two portions (as if for cell-division) before conjugating; and then there is a collateral conjugation of the two pairs, two sporangial frustules being the result. In *Melosira* (Pl. 10. fig. 8) and *Orthosira* (Pl. 10. fig. 9) the appearances presented seem to indicate that the conjugation takes place between two segments of a frustule which have separated as if for ordinary cell-division; but, instead of forming new half-frustules, have coalesced again and secreted a coat over the entire surface, thus constituting one new independent sporangial frustule of larger size. In *Achnanthes* and *Rhabdonema*, two sporangial frustules are formed after the conjugation of the two halves of one (just-divided) frustule. Probably this is a case of very early division of the conjugation-body. In *Melosira* (Pl. 10. fig. 8) the conjugation-body has been observed to

increase by cell-division, and form a new filament of far greater diameter than that to which it owed its birth. The sporangial frustules of the free forms doubtless increase by cell-division in the usual way (see CONJUGATION).

In some cases the first product of the conjugated mass is a siliceous sheath, inside which a new frustule is developed, and finally set free by dehiscence of the sheath (see NAVICULA).

A great difficulty meets us here. The necessary consequence of the conjugation just described is, that every species in which it occurs must be represented by two forms, one small and the other large, between which a gap exists, over which we have at present no means of bridging; except by supposing that the two new halves formed in cell-division need not always be equal, and that, by a dwindling away through a succession of steps of this kind, the progeny of the sporangial frustules may be reduced to the original size. The size of the frustules is said also to vary with the depth of the sea, in marine species. The effect of all this seems to have been disregarded in systematic treatises on the Diatomaceæ. Some of the book-species appear to produce other book-species by conjugation; according to Focke, *Surirella splendida* produces *S. bifrons*, a very distinct form; and it is not improbable that *S. splendida* is produced by the conjugation of *S. Microcora* (Focke). There is great probability, however, that the observations made by Focke upon the contents in certain species will lead to the discovery of another mode of increase—a reproduction by gonidia, either active or quiescent, such as occurs in the Desmidiaceæ and the other Confervoids. Indeed the contents of the cells of *Melosira* have been observed to display a motion like 'swarming.' Such spores or gonidia discharged from the large 'sporangial' frustules might reproduce the small form, just as the young filaments developed from the zoospores of *Chætophora* &c. are very slender compared with those of full-grown filaments. Focke describes and figures appearances in the contents of the frustules of *Pinnularia viridis*, *Surirella bifrons*, and others, very like what occur occasionally in the cell-contents of *Closterium*, namely encysted globules (Pl. 10. fig. 10) resembling the resting-spores of *Volvox* and the filamentous Confervæ (ŒDOGONIUM); and he considers that such bodies produced in *S. bifrons* may probably reproduce *S. Microcora*. In some of Thwaites's figures of conjugating Diatomaceæ (Pl. 10. fig. 6), there are appearances which would lead to the idea that spores were occasionally produced in this process.

The principal attraction of the Diatomaceæ to microscopists, however, lies at present in the structure of the siliceous coats.

Some remarks upon the method of rendering the markings visible have been made in the INTRODUCTION, p. xxviii (*Illumination*); and upon the cause of their becoming visible under proper illumination, in the article ANGULAR APERTURE. The grounds for the belief that most the finer markings are depressions have also been mentioned (INTRODUCTION, p. xxxix, *l.*). But the general view now entertained is, that the finer markings of the valves are the optical expression of hemispheres of silica (Pl. 15. fig. 46); although it is curious, that neither Schultze nor Abbe agree with this view. Yet the formation of the various costæ, vittæ, and other siliceous structures in the valves, cannot be referred to any simply crystalline or crystalloid hemispherical deposition.

Preparation of the valves, to render them as distinct as possible, is essential. This may be effected in two ways:—1. By incinerating them upon a very thin plate of mica or platinum foil over the flame of a spirit-lamp. This is the quickest method; but it has the disadvantages of the valves often becoming semifused or agglutinated to each other by the effects of the heat in the presence of the alkaline salts contained in all organic matters, especially those which are of marine origin. 2. Boiling with strong nitric acid; this is the best method. The water containing the Diatomaceæ is allowed to settle for twenty-four hours, the supernatant liquid poured off, and the deposit dried in a porcelain dish. Strong nitric acid is then added, the whole mixed with a feather or glass brush, and poured into a flask or test-tube and boiled for some time, a portion being removed occasionally with a narrow dip-tube to determine when the valves are perfectly clean. When this is the case distilled water is added to the mixture, and the whole allowed to settle. The supernatant liquid is then carefully decanted, more water added, and the mixture again allowed to settle, poured off, and these operations repeated until a drop of the liquid

containing the valves, when evaporated on a slide, leaves no film (of calcareous salts) at the margins of the drop. This is a somewhat tedious process; but it is essential that it should be thoroughly carried out. If the valves be not thoroughly washed, the film of nitrate of lime remaining upon the slide will absorb water from the atmosphere, and the whole will be spoiled.

It has been found advantageous, after the treatment of the valves with acid and washing, to shake them up with a mixture of equal parts of glycerine and water; they then sink through the water into the glycerine, the flocculent matter being retained by the water. Thorough washing and decantation will then remove the glycerine (Neil). Boiling with a small portion of yellow soap, after the acid treatment, is highly recommended (H. L. Smith).

The appearance of the valves thus prepared will vary according to their structure, and the manner in which they are examined. In some cases the valves appear colourless, and the markings perfectly distinct with the ordinary direct light of the mirror, provided the power be sufficient (Pl. 17. figs. 2, 29; Pl. 51. fig. 1). In others (Pl. 15), the valves appear coloured when viewed by the ordinary light. But when the mirror is brought to one side, and the light is thus thrown upon the object obliquely, one or two sets of fine parallel black lines are seen traversing the valves (Pl. 1. figs. 17, 18; Pl. 15. figs. 10, 12, 15, &c.). And when an object-glass of considerable aperture is used, with the condenser and central stop exactly centrical (Introduction, p. xix), the lines are replaced entirely or in part by a series of black dots (Pl. 1. fig. 16; Pl. 15. figs. 39,40, &c.); these, under a high eyepiece, have distinctly angular forms, sometimes appearing regularly hexagonal (Pl. 15. fig. 41). If the condenser and stop be not exactly centrical, or the surface of the valve be not flat, the appearance of dark dots will be replaced by that of a set of brilliant pearls (Pl. 15. fig. 46), which, as we have stated, many observers consider to represent little hemispherical elevations on the surface of the valves; or the true form of the dark dots will be replaced by some other; thus hexagonal dots may be made to appear triangular, quadrangular, &c., and those dots which cannot be conceived to be really hexagonal (Pl. 15. fig. 39) may be made to appear so.

There can be little doubt that the valves of all the Diatomaceæ are furnished with markings, although in some of them they have not yet been detected. In the most difficultly resolvable of those at present known, lines only can be rendered evident, although these probably consist of rows of dots; these very difficult valves require the use of an Amici's prism (Introduction, p. xxi), Powell's latest modified Gillett's condenser, the method described in the Introduction, p. xxx, with immersion-lenses, or Wenham's reflex-illuminator (See also Illumination).

We have already stated that we believe the dots to consist of depressions. In reviewing the considerations relating to this point, we may divide the valves into those which exhibit the dots by ordinary light, and those which require oblique light and the use of stops.

In those visible with ordinary light (Pl. 17. fig. 29; Pl. 51. fig. 1, &c.), the valves are thinner and weaker at the parts occupied by the dots, so that the line of fracture corresponds to these parts and the depressions, are distinctly visible at the edges of the curved portions of the valves (Pl. 17. fig. 2 *b*). In those requiring the use of oblique light and stops, the line of fracture also corresponds to the rows of dots, provided the light be equally oblique on all sides; and the same appearances are presented by the dots in both cases, beginning with those in which they are very large (as in *Isthmia*), to those of moderate and small size (as in the species of *Coscinodiscus*), down to those in which they are extremely minute (as in *Gyrosigma* &c.). Moreover, analogy affords a strong confirmatory ground; for the Diatomaceæ form a very natural family: and if the dots are depressions in some genera, we might expect them to be so in the others.

The explanation of the manner in which oblique light renders the dots visible, has been given under Angular Aperture.

The method of determining the structure of the frustules of the Diatomaceæ is the same as that of microscopic bodies in general, and has been laid down in the Introduction, p. xxxviii. The presence or absence of a gelatinous envelope or a stipes should first be decided. The general form of the frustules, both in the front and side view, is next examined, which should be done while they are immersed in water, —the frustules being made to roll over by gently moving the glass cover with the point of the mounted needle, the eye being

kept upon the object, and a somewhat low power used.

The frustules should then be prepared, and examined when dry as to their markings. Perhaps these may be visible by ordinary light; if not, the mirror should be turned on one side as much as possible, to obtain the effects of oblique light. If lines then become visible, it does not follow that the valves are marked with lined structures such as grooves or ridges, because the shadows of rows of dots may become extended into lines under oblique illumination in any direction in which the dots will form a linear series. This point must, however, be decided by examination with the aid of the condenser, stops, &c.

In using very oblique unilateral light, spurious rows of parallel lines are often seen, not only upon the valves of the Diatomaceæ, but upon objects not possessing a lined structure, as many crystals &c. These can only be distinguished from those connected with the presence of dots, by their not being resolvable into dots, their greater coarseness, and their variability in number in a given space under different kinds of illumination.

If the direction of the lines changes with the variation of the position of the valve to that of the incident light, it may be pretty surely predicted that the lines are spurious, and that the condenser and stops will effect their resolution into dots.

The prepared valves of the Diatomaceæ frequently appear coloured when dry, the colour vanishing when they are moistened. This colour arises from iridescence, and not from the presence of pigment or other colouring-matter (INTRODUCTION, p. xxxiv, 3).

Collection. In collecting the Diatomaceæ, a number of phials (1- to 2-oz.), with wide mouths and furnished with corks, must be provided, in which they may be brought home. The mouth of the bottle being closed with the thumb and brought as closely as possible to masses of them in the water, on removing the thumb, the water will enter and carry the Diatomaceæ with it into the bottle. A spoon is frequently of use in removing layers of them from the bottom of the water, or from pieces of woodwork &c. immersed in the water. Many of them are entangled in the meshes of Confervæ and other Algæ, or on the submersed stems of the higher plants; these, if fixed to the stems, can only be removed with them; if, however, the masses of Diatomaceæ are merely entangled in the meshes of their stems, they may be detached and collected in the "ring-net" (INTRODUCTION, p. xxviii), and the pieces of muslin placed in the bottles. A stick with a loop of string at the end, is often useful in procuring those which would be otherwise beyond reach: the neck of the bottle being engaged in the loop, and the mouth kept downwards when immersed in the water until opposite and close to the masses of Diatomaceæ, it is then inclined upwards and filled. On exposing the bottles to the light for some hours, the Diatomaceæ will collect on the surface of the mud or other matters, and can then be removed with a dipping-tube. It is often difficult to free them from minute particles of sand; this may, however, generally be done by diffusing the deposit through distilled water, allowing the mixture to stand for a short time, and then pouring off the uppermost portions; the sand being the heaviest, will subside first. The deep-sea species may be obtained by dredging, or by treating the alimentary canal of fishes, mollusca, &c. with strong nitric acid as above directed.

The Diatomaceæ are often found fossil; occurring in vast numbers in freshwater and marine geological deposits, forming hills, rocks, and various strata; also in peat-beds, fossil polishing powders, as tripoli, berg-mehl, &c. The deposits from Franzenbad, Bilin, Richmond (U.S.). San Fiore (Tuscany), Bermuda, Lough Morne (Ireland), Peruvian guano, &c., are well known as containing many of the most beautiful species, and are sold by the dealers in microscopic objects and apparatus.

The masses may sometimes be disintegrated by placing lumps in a test-tube, covering them with *Liquor Potassæ*, boiling for a short time until the whole breaks up into a mud, and then instantly pouring it into a quantity of distilled water, and well washing.

Preservation. The Diatomaceæ may be preserved either in the dry state, immersed in balsam, in water, or dilute spirit one to six (PRESERVATION). For exhibiting the delicate markings, they should be mounted in the dry state, placed upon and covered by the thinnest glass which can be obtained.

The mounted sable-hair or bristle will be essential in isolating single valves (INTRODUCTION, p. xxvi) for mounting.

With regard to the systematic arrange-

ment of the Diatomaceæ, it appears impossible at present to divide them satisfactorily. The structure of the frustules of many genera is imperfectly known and described; and the supposed species have hitherto been viewed rather in relation simply to their differences in form, than to their specific relations.

The following synopsis, however, will serve to aid in comparing the principal genera scattered through the work. In it, we have used fr. to denote the frustules as seen in front view; v. the valves; granular striæ for striæ resolvable into dots, continuous striæ being costæ or canaliculi. The genera included within brackets are not British, or have been imperfectly described.

Analysis of the Tribes and Genera.

* *Frustules not enveloped in a gelatinous mass, nor in gelatinous tubes.*

Tribe 1. *Striatæ*. Frustules usually transversely striate, but neither vittate nor areolate.

† *Valves without a median nodule.*

Cohort 1. EUNOTIEÆ. Fr. arcuate, single or united into a straight filament.

Epithemia. Fr. single or binate, with transverse or slightly radiant striæ, some at least continuous; no terminal nodules; freshwater and marine (Pl. 16. fig. 32).

Eunotia. Fr. single or binate; v. with slightly radiant granular striæ, and terminal nodules; freshwater (Pl. 51. fig. 27).

Himantidium. Fr. as in *Eunotia*, but united into a filament; striæ parallel, transverse; freshwater (Pl. 16. fig. 36).

[*Amphicampa.* Fossil (Pl. 18. figs. 11, 12).]

Coh. 2. MERIDIEÆ. Fr. cuneate, single or united into a curved or spiral band; valves with continuous or granular striæ.

Meridion. Fr. cuneate, united into a spiral band; striæ continuous; freshwater (Pl. 16. fig. 28; Pl. 17. fig. 7).

Eucampia. Fr. united into an arched band; v. punctate; marine (Pl. 50. fig. 10).

[*Oncosphenia.* Fr. single, cuneate, uncinate at the narrow end; striæ granular; freshwater.]

Coh. 3. FRAGILARIEÆ. Fr. quadrilateral, single or united into a filament or chain; v. with continuous or granular striæ.

Diatoma. Fr. linear or rectangular, united by the angles so as to form a zigzag chain; striæ continuous; freshwater and marine (Pl. 16. fig. 26).

Asterionella. Fr. adherent by the adjacent angles into a star-like filament; v. inflated at one or both ends; freshwater (Pl. 18. fig. 14).

Fragilaria. Fr. linear, united into a straight close filament; striæ granular, faint; freshwater and marine (Pl. 16. fig. 33).

Denticula. Fr. linear, single or binate, rarely more united; striæ continuous; freshwater (Pl. 16. fig. 25).

Odontidium. As *Denticula*, but fr. forming a close filament; freshwater and marine (Pl. 17. fig. 14).

Cymatosira. Frustules united, margin undulate in front view; valves lanceolate, punctate, obtuse, without a longitudinal line; marine (Pl. 51. fig. 35).

Plagiogramma. Frustules quadrangular, free, forming filaments; valves with two transverse-median and terminal costæ, the intervals transversely striated; marine (Pl. 51. fig. 41).

Coh. 4. MELOSIREÆ. Fr. cylindrical, disk-shaped, or globose; v. punctate, or often with radiate continuous or granular striæ.

Cyclotella. Fr. disk-shaped, mostly solitary; v. with radiate marginal striæ; freshwater (Pl. 16. figs. 21, 22).

Melosira. Fr. cylindrical or spherical, united into a filament; v. punctate, or with marginal radiate granular striæ; freshwater and marine (Pl. 17. figs. 5, 6).

Podosira. Fr. united in small numbers, cylindrical or spherical, fixed by a terminal stalk; v. hemispherical, punctate; marine (Pl. 19. fig. 34).

[*Mastogonia.* Fr. single; v. unequal, angular, mammiform, circular at base, without umbilical processes; angles radiating; fossil (Pl. 18. figs. 23 *a*, *b* 24, 25).

Pododiscus. Fr. single or united, with a marginal stalk; v. circular, convex (Pl. 17. fig. 16).

Pyxidicula. Fr. single or binate, free or sessile; v. convex; hoop absent?; freshwater and marine (Pl. 25. fig. 13).

Stephanodiscus. Fr. single, disk-shaped;

v. circular, equal, punctate or striate, with a fringe of minute marginal teeth; freshwater (Pl. 18. figs. 26, 27, 28, 29).

Stephanogonia. Fr. as in *Mastogonia*, but ends of valves truncate, angular, and spinous; fossil (Pl. 18. fig. 30).

Hercotheca. Fr. single, turgid laterally; v. with marginal free setæ (Pl. 18. fig. 31).

Goniothecium. Fr. single, constricted in the middle, suddenly attenuate and truncate at the ends (hence appearing angular) (Pl. 51. figs. 18–23).]

Coh. 5. SURIRELLEÆ. Fr. single or binate, quadrilateral, oval, or saddle-shaped, sometimes constricted in the middle; v. with transverse or radiating continuous or granular striæ, interrupted in the middle, or with one or more longitudinal rows of puncta; often keeled.

Bacillaria. Fr. prismatic, straight, at first forming a filament; v. with a median longitudinal row of puncta; marine (Pl. 16. fig. 14).

Campylodiscus. Fr. single, free, disk-shaped; v. curved or twisted (saddle-shaped); freshwater and marine (Pl. 16. fig. 16; Pl. 25. fig. 18).

Doryphora. Fr. single, stalked; v. lanceolate or elliptical, with transverse granular striæ (Pl. 16. fig. 29).

Podocystis. Fr. attached, sessile; v. with a median line, transverse-continuous and intermediate granular striæ (Pl. 51. fig. 7).

Nitzschia. Fr. free, single, compressed, usually elongate, straight, curved or sigmoid, with a not-median keel, and one or more longitudinal rows of puncta; freshwater and marine (Pl. 17. figs. 9–13).

Cymatopleura (*Sphinctocystis*). Fr. free, single, linear, with undulate margins; v. oblong or elliptical, sometimes constricted in the middle; freshwater (Pl. 16. figs. 23, 24).

Surirella. Fr. free, single, ovate, elliptical, oblong, cuneate, or broadly linear; v. with a longitudinal median line or clear space, margins winged, and with transverse or slightly radiating continuous striæ; freshwater and marine (Pl. 17. figs. 21–22).

(*Plagiodiscus.*)

Synedra. Fr. prismatic, rectangular, or curved; at first attached to a gelatinous lobed cushion, often becoming free; v. linear or lanceolate, usually with a median pseudo-nodule and longitudinal line; freshwater and marine (Pl. 17. figs. 23–25).

Tryblionella. Fr. free, linear or elliptical; v. plane, with a median line, transverse striæ, and submarginal or obsolete alæ; freshwater and marine (Pl. 17. figs. 30–32).

Rhaphoneis = *Doryphora* without a stalk.

Coh. 6. AMPHIPLEUREÆ. Fr. free, single, straight or slightly sigmoid; v. lanceolate, or linear-lanceolate, with a median longitudinal line.

Amphipleura. Char. as above (Pl. 16. fig. 7 *a*, *b*, *c*).

Cylindrotheca (Pl. 51. fig. 34).

†† *Valves with a median nodule.*

Coh. 7. COCCONEIDÆ. Fr. straight or bent, attached by the end or side; valves elliptical, equilateral.

Cocconeis. Fr. single, compressed, adnate; v. elliptical, one of them with a median line (Pl. 16. figs. 17, 18).

Coh. 8. ACHNANTHEÆ. Fr. bent, stalked at one angle or free; v. with a stauros.

Achnanthes. Fr. compressed, single or rarely united into a straight filament, curved, attached by a stalk at one angle; uppermost valve with a longitudinal median line, lowermost with the same, and a stauros or transverse line; marine (Pl. 16. figs. 1–4).

Achnanthidium. Fr. those of *Achnanthes*, but free; freshwater (Pl. 16. figs. 5, 6).

Cymbosira. Fr. those of *Achnanthes*, solitary or binate, stipitate, and attached end to end; marine (Pl. 19. fig. 18).

Coh. 9. CYMBELLEÆ. Fr. straight or curved, free or stalked at the end; v. inequilateral, not sigmoid.

Cymbella. Fr. free, solitary; v. navicular, with a subcentral and two terminal nodules, and a submedian longitudinal line; freshwater (Pl. 51. fig. 2).

Cocconema. Fr. those of *Cymbella*, but stalked; freshwater (Pl. 16. figs. 19, 20).

Coh. 10. GOMPHONEMEÆ. Fr. wedge-shaped, straight, free or stalked; v. equilateral.

Gomphonema. Fr. single or binate, wedge-shaped, attached by their ends to a stalk; v. with a median line, and a median and terminal nodules; freshwater (Pl. 16. fig. 34).

[*Sphenella.* Fr. free, solitary, wedge-shaped, involute; freshwater (Pl. 19. fig. 19).

Sphenosira. Fr. united into a straight filament; v. wedge-shaped, at one end rounded, suddenly contracted and produced; freshwater (Pl. 17. fig. 26).]

Coh. 11. NAVICULEÆ. Fr. free, straight; v. equilateral, or sometimes sigmoid.

Navicula. Fr. single, free, straight; v. oblong, lanceolate or elliptical, with a median line, a central and two terminal nodules, and transverse or slightly radiant lines resolvable into dots; freshwater, marine, and fossil (Pl. 15. figs. 6–9).

(*Stigmaphora.*)

Pleurosigma. Fr. those of *Navicula*, but valves sigmoid; freshwater and marine (Pl. 15. figs. 10–38).

(*Toxonidea.*)

Pinnularia. Fr. those of *Navicula*, but transverse lines continuous and not resolvable into dots; freshwater and marine (Pl. 15. figs. 1–5).

Stauroneis. Fr. those of *Navicula*, but the median nodule replaced by a stauros; freshwater and marine (Pl. 15. figs. 43–45).

Staurosigma. Fr. those of *Stauroneis*, with a sigmoid longitudinal line.

Diadesmis. Fr. those of *Navicula*, united into a straight filament; freshwater (Pl. 16. fig. 27).

Amphiprora. Fr. free, solitary or in pairs, constricted in the middle; v. with a median keel, and a median and terminal nodules, often twisted; marine (Pl. 16. fig. 8).

(*Donkinia.*)

Amphora. Fr. plano-convex, elliptical, oval or oblong, solitary, free or adnate, with a marginal line and a nodule or stauros on the flat side; freshwater and marine (Pl. 16. figs. 10, 11).

Perizonium. Frustules navicular, free, with thickened zones (Pl. 51. fig. 42.)

Tribe II. *Vittatæ.* Fr. with vittæ.

† *Valves without a median nodule.*

Coh. 12. LICMOPHOREÆ. Fr. cuneate; vittæ arched.

Licmophora. Fr. cuneate, rounded at the broad end, radiating from a branched stalk; vittæ curved (formed by inflection of the upper margins of the valves); marine (Pl. 17. fig. 3).

Podosphenia. Fr. those of *Licmophora* but single or in pairs, sessile upon a thick but little-branched pedicel; marine (Pl. 17. fig. 17).

Rhipidophora. Fr. those of *Licmophora*, single or in pairs, upon a branched stipes; marine (Pl. 17. fig. 19).

Climacosphenia. Fr. cuneate, rounded at the broad end, divided into loculi by transverse septa or vittæ; marine (Pl. 25. fig. 9).

Coh. 13. STRIATELLEÆ. Fr. tabular or filamentous; vittæ straight (not arched).

Striatella. Fr. compound, stalked at one angle; vittæ longitudinal and continuous; v. elliptic-lanceolate, not striated (ord. illum.); marine (Pl. 17. fig. 20).

Rhabdonema. Fr. as in *Striatella*, but vittæ interrupted, and v. with transverse granular striæ; marine (Pl. 17. fig. 18).

Tetracyclus. Fr. compound, filaments compressed; vittæ alternate, interrupted; v. inflated at the middle; costæ transverse, continuous; freshwater (Pl. 17. fig. 28).

Tabellaria. Fr. united into a filament, subsequently breaking up into a zigzag chain; vittæ interrupted, alternate; v. inflated at the middle and ends; freshwater (Pl. 17. fig. 27).

[*Pleurodesmium.* Fr. tabular, united into a filament, and with a transverse median hyaline band; marine.

Hyalosira. Fr. tabular, fixed by a stalk at one angle; vittæ alternate, interrupted, bifurcate at the end; marine (Pl. 17. fig. 1).

Anaulus. Fr. rectangular, single, compressed, with lateral inflections, giving the valves a ladder-like appearance; marine (Pl. 18. fig. 7).

Biblarium. Fr. as in *Tetracyclus*, but single; fossil (Pl. 50. fig. 39; Pl. 18. figs. 35–48).

Terpsinoe. Fr. tabular, obsoletely stalked, subsequently connected by isthmi; vittæ transverse, short, interrupted and capitate; freshwater and marine (Pl. 25. fig. 10; Pl. 19. fig. 33).

Stylobiblium. Fr. compound; v. circular, sculptured with continuous striæ; fossil (Pl. 18. fig. 50).]

†† *V. with a median apparent (pseudo-) nodule.*

Grammatophora. Fr. at first adnate,

afterwards forming a zigzag chain; vittæ two, longitudinal, interrupted at ends, and more or less figured; marine (Pl. 1. figs. 14, 15).

Diatomella. Fr. quadrangular; vittæ two, interrupted in the middle and at each end (Pl. 51. fig. 16).

Tribe III. *Areolatæ.* Valves circular, with cell-like (areolar) markings, visible by ordinary illumination.

Subtribe 1. **Disciformes.** Valves alike, without appendages or processes.

Coh. 14. COSCINODISCEÆ. Valves circular.

Actinocyclus. Fr. solitary; v. circular, undulate, the raised portions appearing as rays or bands radiating from the centre, which is free from markings; marine and fossil (Pl. 25. fig. 17).

Actinoptychus. Fr. as in *Actinocyclus*, but radiating internal septa, as well as rays; marine and fossil (Pl. 25. fig. 16).

Coscinodiscus. Fr. single; v. circular, areolar all over; marine and fossil (Pl. 51. fig. 1; Pl. 25. figs. 7, 8).

Arachnoidiscus. Fr. single; v. circular, not undulate, with concentric and radiating lines, and intermediate areolæ, absent from the centre (pseudonodule); marine and fossil (Pl. 16. fig. 12).

Asterolampra. Fr. single; v. circular, finely areolar, except in the centre and on equidistant clear marginal rays radiating from the centre, which is traversed by radiating dark lines (septa) alternating with the marginal rays; fossil (Pl. 25. fig. 5).

Asteromphalos. As *Asterolampra*, but two of the central dark lines parallel, and the corresponding marginal ray obliterated; fossil (Pl. 25. fig. 2; Pl. 18. fig. 15).

Halionyx. Fr. single; v. circular, without septa, with rays not reaching the centre, and with intermediate shorter rays; between the rays transverse (concentric?) areolar lines; fossil (Pl. 18. fig. 51).

Odontodiscus. Fr. single, lenticular; v. covered with puncta (areolæ) arranged in radiating rows or excentrically curved lines, and with erect marginal teeth; fossil (Pl. 18. fig. 52).

Omphalopelta. As *Actinoptychus*, but upper part of margin of valves with a few erect spines; fossil (Pl. 18. fig. 53).

Symbolophora. Fr. single, disk-shaped; v. with incomplete septa radiating from the solid angular umbilicus, and intermediate bundles of radiating lines; marine and fossil (Pl. 25. fig. 6; Pl. 18. figs. 54, 55, 56).

Systephania. Fr. single; valves circular, areolar, without rays or septa, with a crown of spines or an erect membrane on the outer surface of each valve; fossil (Pl. 18. figs. 57, 58).

Coh. 15. ANGULIFERÆ. Valves angular.

Amphitetras. Fr. at first united, afterwards separating into a zigzag chain, rectangular; v. rectangular, the angles often produced; marine (Pl. 16. fig. 9).

Amphipentas. Fr. solitary; v. pentagonal; fossil (Pl. 25. fig. 11).

Lithodesmium. Fr. united into a straight filament; v. triangular, one side plane, the others undulate; marine (Pl. 17. fig. 4).

Tribe IV. *Appendiculatæ.* Valves with processes or appendages, or with the angles produced or inflated.

Coh. 16. EUPODISCEÆ. Fr. disk-shaped; v. circular.

Eupodiscus. Fr. single, disk-shaped; v. circular, with tubular or horn-like processes on the surface; freshwater and marine (Pl. 16. figs. 30, 31).

[*Auliscus.* As *Eupodiscus*, but processes obtuse and more solid; fossil (Pl. 18. fig. 60).

Insilella. Fr. single, fusiform; v. equal, with a median turgid ring between them=terete *Biddulphia*; marine.]

Coh. 17. BIDDULPHIEÆ. Fr. flattened; v. elliptical or suborbicular.

Biddulphia. Fr. rectangular, more or less united into a continuous or zigzag filament; the angles inflated or produced into horns; v. convex, centre usually spinous; marine (Pl. 16. fig. 15; Pl. 19. fig. 9).

Isthmia. Fr. rhomboidal or trapezoidal, cohering by one angle; angles produced; marine (Pl. 17. fig. 2).

Chætoceros. Fr. compressed; v. equal, with a long spine or filament on each side; marine (Pl. 50. fig. 47).

Rhizoselenia. Fr. elongate, subcylindrical, marked with transverse or spiral

lines, ends oblique or conical, and with one or more terminal bristles; marine (Pl. 50. fig. 46).

Corinna. Fr. united into semicircular bands; angles produced, spiniferous, intermediate portion hemispherical, septate; valves ellipsoid, transversely bicostate, apiculate at each end.

[*Hemiaulus.* Fr. single, compressed, rectangular, angles produced into tubular direct processes, those on one valve longer than those on the other; fossil (Pl. 25. fig. 3).

Syringidium. Fr. single, terete, acuminate at one end, two-horned at the other; marine (Pl. 18. figs. 32, 33).

Peripteria. Fr. single, compressed; v. unequal, one simply turgid, the other with marginal wings or spines; fossil (Pl. 18. figs. 66, 67).

Dicladia. Fr. single; v. unequal, one turgid and simple, the other two-horned; fossil (Pl. 18. figs. 61-65).

Trinacria. Porpeia. Hydrosera (Pl. 51. fig. 40). *Solium. Zygoceros. Glyphodiscus. Attheya* (Pl. 51. fig. 39).]

Coh. 18. ANGULATÆ. Valves angular.

Triceratium. Fr. free; v. triangular, each angle with a minute tooth or horn; marine (Pl. 17. fig. 29).

[*Syndendrium.* Fr. single, subquadrangular; v. unequal, strictly turgid, one smooth, the other with numerous median spines or little horns branched at the ends (Pl. 18. fig. 59).]

Rabenhorst makes the Angulatæ a subfamily of Biddulphieæ; comprising the European genera *Triceratium, Trinacria,* and *Lithodesmium.*

** *Frustules enveloped in a mass of gelatine, or contained in gelatinous tubes, forming a frond.*

Mastogloia. Frond mammillate; frustules like *Navicula,* but hoops with loculi; freshwater and marine (Pl. 51. fig. 26).

Dickieia. Frond leaf-like; frustules like *Navicula* or *Stauroneis*; marine (Pl. 19. fig. 16).

Berkeleya. Frond rounded at base, filamentous at circumference; frustules navicular; marine (Pl. 19. fig. 8).

Homœocladia. Frond sparingly divided, filiform; frustules like *Nitzschia,* marine (Pl. 19. fig. 15).

Rhaphidoglœa. Frustules those of *Amphipleura,* tufted in radiating gelatinous filaments (Pl. 19. fig. 11).

Colletonema. Frond filamentous, filaments not branched; fr. like *Navicula* or *Pleurosigma*; freshwater.

Schizonema. Frond filamentous, branched; fr. like *Navicula*; marine (Pl. 19. fig. 12).

Encyonema. Frond filamentous, but little branched; fr. like *Cymbella*; freshwater (Pl. 19. fig. 10).

Syncyclia. Fr. those of *Cymbella,* united in circular bands, immersed in an amorphous gelatinous frond; marine (Pl. 19. fig. 14).

Frustulia. Fr. those of *Navicula,* irregularly scattered through an amorphous gelatinous mass; freshwater (Pl. 19. fig. 17).

Micromega. Fr. those of *Navicula,* arranged in rows, in gelatinous tubes, or surrounded by fibres, these being enclosed in a filiform branched frond; marine (Pl. 17. fig. 8).

Many other species are noticed and figured in this work under the genera, which have not been described with sufficient brevity to allow of their being tabulated, or are not well established.

BIBL. Ralfs, *Ann. N. H.* 1843, xi. 447, xii. 104, 271, 346, 457; Thwaites, *Ann. N. H.* 1847, xix. 200, xx. 9, 343; 1848, i. 161; Smith, *Br. Diat.*; Bailey, *Silliman's Jn.* xli., xlii.; id. *Ann. N. H.* 1851, viii. 157, and *Smithson. Contrib.* 1854; Ehrenberg, *Inf.*; id. *Berl. Abh.* 1839, 1840; id. *Berl. Ber. passim*; id. *Mikrogeologie*; Brébisson, *Diatomées*; Kützing, *Bac.* and *Sp. Algarum*; Pritchard, *Inf.* (*full account of species*); Braun, *Verjüng.* (*Ray Soc.* 1853); Nägeli, *Einzell. Alg.* 9: Focke, *Physiol. Studien,* 1853; Meneghini, *Sull' Animalit.* &c. (*Ray Soc.* 1853); Gregory, *Diat. Clyde,* 1857; Smith (*South France*) *Qu. M. Jn.* 1855; id. (*Pyrenees*), 1857; Greville, *Qu. M. Jn.* 1859 (Californian), 1865 (Hong Kong), 1; H. L. Smith, *Ann. N. H.* 1869, iv. 218; Grunow, *Verh. zool.-bot. Gesellsch. Wien,* 1858, '60, '62; *Qu. M. J.* 1877, 166 (*Honduras*); Nylander, *Diat. Fenniæ fossil. addit.* 1861; Weisse, *Schwarz-Erde* (*Tschernozjom*), 1855; Heiberg, *Consp. Diat. danic.* 1863 (6 pls.); Wenham, *M. Mic. Jn.* ii. 158 (*illuminating*); *Qu. M. J.* 1855, iii. 244; Wallich, *Mic. Tr.* 1860, 129, viii. 36; *Ann. N. H.* 1863, xi. 351; *M. M. J.* 1877, xvii. 61; Schultze, *Struct. d. Diat.-Schale, Verhandl. Naturh. Ver. preuss. Rheinl.* xx.

1 (figs.), *abr. in Qu. M. Jn.* 1863, iii. 120; Antelminelli, *Qu. M. Jn.* 1868, 254 (*reproduct.*); Flögel, *Arch. mikr. An.* iv. 472; Macdonald, *Ann. N. H.* 1869, iii. 1; Manoury, *Diat.* 1870; Fritsch & Müller, *Skulptur*, 1870 (*excellent photographs*); Donkin, *Br. Diat.* 1871; Rabenhorst, *Fl. Alg.* i.; Pfitzer, *Hanstein's Bot. Abh.* 1871, ii. 120; Millardet and Kraus, *Compt. rendus*, lxvi. 505; Askensky, *Bot. Zeit.* 1869, 790; Luders, *Bot. Zeit.* 1862 (*colouring matter*); Hickie, *Schumann's Diat. formulæ*, *M. M. J.* 1875, xiv. 6; Habirshaw, *Catal. Diat.* 1877; Lewis, *Diat. of United-St. Seaboard*; Schmidt, *Atlas* (*figs. of all species &c.*), 1878; Pettitt, *Jn. Mic. Soc.* 1878, i. 237, pls. (*Campbell Island*), & *Bull. Soc. Bot. d. France*, xxiii. & xxiv. (*Kitton*, *M. M. Jn.* 1877, xviii. 10 & 65; *classn.*); Cox, *Amer. Jn. Mic.* 1878, iii. 100; Heurck, *Syn. Diat.* 1880 (*Belgique*, pls.); Cleve & Grunow, *Diat. Arct.* 1880; Lanzi, *An. Soc. Belge* (*Jn. Mic. Soc.* ii. 1879, 38, *thallus*); Mereschkowsky, *Bot. Zeit.* 1880, xxxviii. 529 (*Jn. Mic. Soc.* 1881, i. 102); Borscow, *Bac. Russlands*, 1873; Engelmann, *Bot. Zeit.* 1879; Hallier, *Diat.* 1880 (*movement*).

DIATOMELLA, Grev. *D. Balfouriana*, Gr. = *Grammatophora B.*, Smith (Pl. 51. fig. 16) = *Disiphonia australis*, Ehr.

DICEL'LA, Werneck.—A doubtful genus of Infusoria (*Berl. Ber.* 1841, 377).

DICHONE'MA, N. ab Es.—A genus of Hymenomycetous Fungi, inhabiting tropical America and Polynesia.

D. sericeum consists of a reticulation of Confervoid filaments, interlaced with mycelium, and at length, like *Cora*, producing a distinct hymenium which cracks into scattered patches. This genus is sometimes called *Dictyonema*. Spreading in an orbicular form, from branches of trees; a curious microscopic object (Leighton).

Bibl. Esenb. *N. Acta*, xiii. 12.

DI'CHROISM (double colour) is the term applied to the property possessed by many doubly refracting crystalline substances, of exhibiting two colours when light is transmitted through them in different positions. It may be observed under the microscope in crystals of the tourmaline, the acetate of copper, the chloride of palladium, and the oxalate of chromium and potash, or of chromium and ammonia.

Dichroism depends upon the absorption of some of the coloured rays of the polarized light in their passage through the crystal—this absorption varying with the different relative positions of the planes of primitive polarization of these rays to the axis of double refraction of the crystals, so that the two pencils formed by double refraction are differently coloured.

In the acetate of copper, the two colours are deep blue and yellowish green; in the chloride of palladium, they are red and green; in the oxalate of chromium and potash they are blue and green, and in the tourmaline they are not always the same. The variation in colour is entirely independent of the thickness of the crystal.

Bibl. Brewster, *Phil. Tr.* 1819, and *Optics*, 353; Herschel, *Encyc. Metr.* art. *Light*, 1064.

DICKIEI'A, Berkeley and Ralfs.—A genus of Diatomaceæ.

Char. Frustules navicular, irregularly scattered through a flat undulate frond or subgelatinous layer, narrowed at the base so as to appear substipitate.

D. ulvoides (Pl. 19. fig. 16: *a*, frond, nat. size; *b*, portion, magnified; *c*, prepared frustule, front view; *d*, valve). Stipes very short, capillary; frond oblong, irregularly lobed or crenulate; frustules oblong, obtuse-angled, truncate at the ends: valves oblong, with a stauros; length of frond 1 to 1½"; of frustules, 1-1000 to 1-720"; marine.

Frond very pale purplish white. Recent frustules with a round colourless spot at each of the four angles (in the front view). Found in shallow pools between high and low-water mark.

D. pinnata. Frond irregularly divided, or laciniate; v. like *Navicula.* Marine.

Bibl. Berkeley and Ralfs, *Ann. N. H.* 1844, xiv. 238, and 1851, viii. 204; Kützing, *Bacill.* and *Sp. Alg.* 109; Thwaites, *Ann. N. H.* 1848, i. 171; Smith, *Brit. Diat.* ii. 106.

DICKSO'NIA, L'Héritier.—A genus of Dicksonieæ (Polypodiaceous Ferns), including fine arborescent species. All exotic.

DICKSO'NIEÆ.—A family of Polypodiaceous Ferns.

Genera: *Onoclea*, *Hypoderris*, *Woodsia*, *Sphæropteris*, *Dicksonia*, and *Deparia.*

Bibl. Hooker, *Syn. Fil.* 45.

DICLA'DIA, Ehr.—A genus of Diatomaceæ.

Char. Frustules single; valves unequal, one turgid and simple, the other two-horned, the horns sometimes branched. Marine and fossil.

D. capreolus (Pl. 18. figs. 63, 64); *D. antennata* (Pl. 18. fig. 61); *D. bulbosa* (Pl. 18. fig. 62); *D. clathrata* (Pl. 18. fig. 65).

Bibl. Ehrenb. *Berl. Ber.* 1844, 73, and *Mikrogeologie*; Bailey, *Sillim. Jn.* 1856; Greville, *Mic. Tr.* 1865, 56, 98.

DICORY'NE, Allm.—A genus of Hydroid Polypi, fam. Atractylidæ.

D. conferta. On old shells, *Buccinum*, &c.

Bibl. Hincks, *Brit. Zooph.* 105.

DICOTYLE'DONS.—One of the two great divisions of the Angiospermous Flowering Plants, synonymous with the *Exogens* of Decandolle, and opposed to Monocotyledons,—the name being derived from the condition of the embryo prevailing throughout the vast majority of plants included in this assemblage. As in all other natural groups, instances occur wherein the particular character from which the name is derived, the presence of a pair of cotyledons in the embryo, is absent, as in *Orobanche*, &c. (like the Orchidaceæ and other plants among the Monocotyledons); but in these cases the plants agree generally with Dicotyledons in all the rest of the prominent characters, such as the structure of stem, leaves, plan of flower, &c. See Vegetable Kingdom, Wood, and Seed.

DICRANA'CEÆ.—A family of Apocarpous operculate Mosses, branching by innovations, or with the tops of the fertile branches several times divided. Leaves lanceolate or subulate, channelled-concave, with a nerve mostly dilated and flattened, rarely slender, scarcely cylindrical. The cells prosenchymatous (often mingled with parenchymatous), rarely papillose, mostly empty, often thickened upwards, thereby rounded or elliptical; the basilar cells arranged in a curved manner at the margins of the leaves, distinctly diverse, parenchymatous, lax, thick, large, flat or with a more or less thick and patelliform front, delicate or robust, hyaline, fuscous, brown or purple, ultimately marcescent, mostly very conspicuous (alar cells). Capsule oval or cylindrical, arched or straight, with a subulate operculum. Peristome, if present, purple, teeth trabeculate.

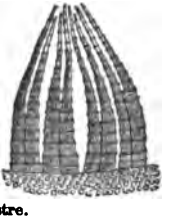
British Genera.

Blindia. Calyptra dimidiate, hood-shaped, peristome wanting or simple, then of sixteen equidistant, lanceolate, distantly articulated, smooth, slender teeth, slightly trabeculate within, purple, cartilaginous. Capsule exannulate.

Dicranum. Calyptra dimidiate. Peristome simple, teeth connate at the base into a more or less emergent membrane, or equidistant and arising below the orifice of the capsule, split more or less deeply, even in some cases to the base, into two or rarely more free arms, purple below, trabeculate-nodose above (figs. 169 & 170).

Fig. 169.

Fig. 170.



Dicranum palustre.

Fig. 169. Mouth of the capsule with the peristome everted. Magnified 40 diameters.
Fig. 170. Portion of the peristome. Magnified 100 diameters.

DI'CRANUM, Hedw.—A genus of Dicranaceæ (Apocarpous operculate Mosses), including numerous British species, very varied in size and habit; some, such as *D. scoparium*, very common (see Angstrœmia and Leucobryum).

Bibl. Wilson, *Bryol. Brit.* p. 61.

DICTYD'IUM, Schrad. —A genus of Myxomycetes; exceedingly elegant little plants, growing upon rotten wood. The peridium is excessively delicate, and the peculiar capillitium adherent to it; so that, when the spores are expelled, the transparent case appears like a cage, formed of the veins alone. There are no filaments mingled with the spores. *D. umbilicatum* (fig. 171) is a British species; it is of a brownish-purple colour until the spores are discharged, then hyaline; it is gregarious in its habit of growth.

Fig. 171.

Dictydium umbilicatum. Magn. 25 diam.

Bibl. Berk. *Hook. Br. Fl.* v. pt. 2. 317; Greville, *Sc. Crypt. Fl.* pl. 153; Fries, *Syst. Myc.* iii. 164; Schrad. *Nov. Gen.* 11; Corda, *Ic. Fung.* v. pl. 3. fig. 36.

DICTY'OCHA, Ehr.—The nature of the curious bodies, of which the genus *Dictyocha* consists, is unknown. They consist

of a single piece; hence they are not Diatomaceæ. This piece is siliceous and loosely reticulate or stellate. Marine and fossil.

Kützing enumerates twenty-nine species; distinguished principally by the number of external spines and internal areolæ; they vary in diameter from 1-1150 to 1-370″.

D. gracilis (Pl. 25. fig. 19, perspective view; 20, side view; 21, view from above).

D. fibula (Pl. 51. fig. 5).

Bibl. Ehrenberg, *Berl. Abh.* 1838, and *Mikrog.*; Kützing, *Bacill.* and *Sp. Alg.* 142; Pritchard, *Inf.* 735.

DICTYOCYS'TA, Ehr.—A genus of Peritrichous Infusoria.

Char. Free; enclosed in siliceous perforated or pitted loricæ, with an anterior fringe of long cilia, and an inner circle of uncini; surface smooth. 6 species. Marine. (Kent, *Inf.* 624.)

DICTYOLAMPRA, Ehr.—A genus of Diatomaceæ.

Char. Frustules single; no internal septa; valves equal, cellular (apparently) in the middle, the smooth margin radiate.

D. stella (Pl. 18. fig. 68). The only species. Found among *Polycystina* from Barbadoes.

Bibl. Ehr. *Ber. Berl. Akad.* 1847, 54.

DICTYOP'TERIS, Presl.—A genus of Polypodiaceous Ferns, deriving their name from the reticulated arrangement of the veins, = *Polypodium*, pt.

DICTYOPYX'IS, Ehr., Grev.—A genus of marine Diatomaceæ.

Char. Frustules areolar, united into short bands; valves convex, cupuliform, hoop absent, = *Pyxidicula*, pt.

D. brevis, Grev.; *D. cruciata*, Ehr.

Bibl. Grev. *Mic. Jn.* 1862, 22 (fig.); Ehr. *Berl. Abh.* 1844; Pritchard, *Inf.* 825; Rabenhorst, *Fl. Alg.* i. 36.

DICTYOSI'PHON, Grev.—A genus of Dictyosiphonaceæ (Fucoid Algæ), represented in Britain by a common branched filamentous sea-weed (*D. fœniculaceus*), with the frond growing from one to several feet long, of an olive or rusty-brown colour. The fructification at present known consists of ovoid sporanges, imbedded in the cellular tissue of the branches, lying lengthways; they open by a pore at the surface.

Bibl. Harvey, *Mar. Alg.* 40, pl. 7 D; Greville, *Alg. Brit.* pl. 8; Thuret, *Ann. Sc. Nat.* 3 sér. xiv. 238.

DICTYOSIPHONA'CEÆ.—A family of Fucoideæ. Olive-coloured sea-weeds with cylindrical branched fronds, the *oosporanges* imbedded lengthways in the substance of the frond, opening by a pore on the surface.

British Genera.

Dictyosiphon. Root a minute naked disk; frond cylindrical, branched; *oosporanges* scattered irregularly, solitary or in dot-like sori.

Striaria. Root a minute naked disk; frond cylindical, branched; *oosporanges* arranged in transverse lines on the surface of the frond.

Bibl. See the genera.

DICTYOSPHÆ'RIUM, Näg.—A genus of Palmellaceous Algæ.

Char. Cells oblong, green, connected by filaments, united into free, rounded, plate-like layers. Freshwater.

2 species. *D. Ehrenbergii* (Pl. 3. fig. 11).

Bibl. Nägeli, *Einzell. Alg.* 73; Archer, *Qu. Mic. Jn.* 1866, 127.

DICTYOSPORIUM, Corda.—A genus of Torulacei (Coniomycetous Fungi) containing one species, *D. elegans* (fig. 172), a minute fungus growing upon oak which has been stripped of its bark; very remarkable for the reticulated character of its spores.

Fig. 172.

Dictyosporium elegans.
Spores magnified 1000 diameters.

Bibl. Berk. & Br. *Ann. Nat. Hist.* 2 ser. v. 460; Corda, *Icon. Fung.* ii. pl. 8. fig. 29.

DICTYO'TA, Lamx.—A genus of Dictyotaceæ (Fucoid Algæ), containing one British species, *D. dichotoma* (Pl. 4. fig. 2), common between tide-marks, on rocks, &c.; remarkable for its dichotomously divided membranous frond, of olive-green colour, 3 to 12″ long, which, on distinct individuals, produces three kinds of reproductive organs, viz. 1. *tetraspores*, divided crucially, and either scattered or arranged in sori; 2. *spores* grouped in sori and covered by the common epidermis of the thallus; and 3. *antheridia*, in patches on either face of the thallus.

Bibl. Harvey, *Brit. Alg.* 39, pl. 7Δ; *Phyc. Brit.* pl. 103; Greville, *Alg. Brit.* pl. 10; Thuret, *Ann. Sc. Nat.* 4 sér. iii. 7, pl. 2.

DICTYOTA'CEÆ.—A family of Fucoideæ. Olive-coloured inarticulate sea-weeds, with large *spores* like those of Fucaceæ, superficial, in definite spots or lines (*sori*),

or scattered. Root coated with woolly fibres. Frond flat.

Many other genera are included in this family by most authors; but Thuret has pointed out that the genera here named produce *spores*, while the structures described as such in the others are *oosporanges*. PADINA presents some interesting points of microscopic structure. All the genera are formed of very regular muriform parenchyma.

British Genera.

Haliseris. *Frond* dichotomous, with a midrib.

Padina. *Frond* ribless, fan-shaped, concentrically streaked. *Sori* linear, concentric, bursting through the epidermis.

Zonaria. *Frond* ribless, lobed, concentrically striate. *Sori* roundish, containing spores and jointed threads.

Taonia. *Frond* ribless, irregularly cleft, somewhat fan-shaped. *Sori* linear, concentric, superficial, alternating with scattered spores.

Dictyota. *Frond* ribless, dichotomous. *Sori* roundish, scattered, bursting through the epidermis, or (on distinct individuals) scattered spores.

For other genera often included here, see SPOROCHNACEÆ, PUNCTARIACEÆ, DICTYOSIPHONACEÆ, and CUTLERIACEÆ.

BIBL. See the genera.

DICTYOXYPH'IUM, Hooker.—A genus of Lindsayeæ (Polypodiaceous Ferns). Exotic.

DICYE'MA, Köll.—A genus of Infusoria (?), allied to *Opalina*.

D. Mülleri is found in the kidneys &c. of Cephalopoda.

BIBL. Erdl, *Erichs. Arch.* 1843, 162; Kölliker, *Würzburg Ber.* 1849; Clap. and Lachm. *Infus.* ii. 201.

DIDER'MA, Pers.—A genus of Myxomycetes, consisting of minute epiphytic plants of tolerably persistent structure (fig. 173). The peculiar character resides in the double layer of the peridium, the outer being smooth and crustlike, fragile and dehiscent, while the inner is very delicate and evanescent. The species vary in habit, being either stipitate with the stalk more (*Leangium*, Lk.) or less (*Leocarpus*, Lk.) distinct in different cases, and sessile. A

Fig. 173.

Diderma lepidotum. Magnified 25 diams.

dozen species are recorded as British, of which the sessile *D. globosum*, and the obscurely stalked *D. vernicosum*, appear the commonest.

BIBL. Berk. *Hook. Brit. Fl.* v. pt. 2. 310; *Ann. N. H.* i. 257; *Crypt. Bot.* 337; Fries, *Syst. Myc.* iii. 96; *Summa Veg.* 450; Greville, *Sc. Crypt. Fl.* pls. 3, 122 & 132; Corda, *Ic. Fung.*

DIDIM'IUM, Stein.—A genus of Peritrichous Infusoria.

Char. Free, ovate, or subcylindrical, with an anterior and posterior ciliary wreath; snout-like in front.

D. nasutum. Pond-water; length 1-300″. (Kent, *Inf.* 638.)

DIDYM'IUM, Schrad.—A genus of Myxomycetes, consisting of minute plants growing upon leaves, bark, rotten wood, &c. (fig. 174), distinguished by its double peridium, of which, however, the inner membranous layer is the true case (bursting irregularly), while the outer forms a kind of bark, which breaks up into little furfuraceous scales or mealy down. Filaments exist twining among the spores adherent to the peridium. Sixteen species are recorded as British, several of which are not uncommon. They vary in habit, like the *Didermæ*, being either stalked, sessile, or adnate to their support. *D. farinaceum* is figured by Sowerby as *Trichia sphærocephala*.

Fig. 174.

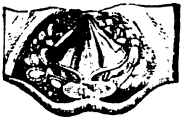
Didymium hemisphæricum. Magnified 25 diams.

BIBL. Berk. *Hook. Br. Fl.* v. pt. 2. 312; *Ann. N. H.* i. 257, 1850, v. 365, xiii. 459; *Crypt. Botany*, 337; Fries, *Syst. Myc.* iii. 113; *Summa Veg.* 451; Sowerby, *Fungi*, pls. 12, 240, 412; Corda, *Ic. Fung.*

DIDYMOCHLÆNA, Desv.—A genus

Fig. 175.

Fig. 176.



Didymochlæna sinuosa.

Fig. 175. A sorus, from above. Magn. 20 diams.
Fig. 176. Transverse vertical section of ditto.

of Aspidieæ (Polypodiaceous Ferns), with a curious elliptical indusium opening on each side (figs. 175 & 176). Exotic.

DIDYMO'CLADON, Ralfs.—A genus of Desmidiaceæ.

Char. Cells single, constricted at the middle, end view tri- or quadrangular; each angle with two processes, one lateral and in the front view nearly parallel with the corresponding one of the other segment, the other superior and divergent.

The two processes distinguish this genus from *Staurastrum*.

D. furcigerus (Pl. 14. fig. 32, front view; fig. 56, end view).

a, end view triangular.

β, end view quadrangular.

Length, including processes, 1-330″.

Bibl. Ralfs, *Brit. Desmid.* 144.

DIDYMOHE'LIX, Griffith.—A genus of Oscillatoriaceæ (Confervoid Algæ), with the threads consisting of pairs of microscopic, interlacing, ferruginous, spiral filaments; probably surrounded by gelatine.

It seems to have no relation with *Gallionella* as formerly supposed.

Found in ferruginous bog-water.

The structure of the compound filaments of which this beautiful and curious organism consists requires great care to elicit, both on account of their minute size and their peculiar form. The breadth of the filaments is from 1-5000 to 1-30,000″, the average 1-10,000 to 1-20,000″. Filaments imbued with peroxide of iron, containing no silica, or not more than a trace, such as is naturally invariably associated with the peroxide. With hydrosulphuret of ammonia, they become black. Acted upon slowly with dilute muriatic acid, the colour gradually vanishes, a very transparent colourless cast of the original being left. If the compound filaments are macerated for some time in distilled water, the filaments will separate (Pl. 1. fig. 10*d*). Under a ¼-inch object-glass, the filaments present the appearance represented in Pl. 1. fig. 10 *a*. When a higher power is used, they appear as in fig. 10 *b*, which represents them as seen when too much liquid is contained between the slide and the cover, or when the proper correction is not made for the thickness of the glass cover and of the liquid, or when lying edgewise. When lying flat upon the slide, and the correction is perfect, they appear as in Pl. 1. fig. 10 *c*.

In the natural state, a quantity of yellowish-brown gelatinous matter is always found in the water containing the filaments. In the ferruginous gelatine are found some fibres of a very minute Nostochaceous plant, probably *Anabaina subtilissima*, Kütz. *Didymohelix* is by no means common, even in waters which contain a very copious ferruginous deposit. It is found in ditches in Dumfriesshire, 10 or 12 inches in thickness.

It may be preserved either in the dry state, in chloride of calcium, or in balsam.

We have enumerated this as a test-object for the general excellence of a high-power object-glass, also of the observer's management of the microscope. See Test-Objects.

Bibl. Griffith, *Ann. Nat. H.* 1853, xii. 438; Davies, *M. M. Jn.* 1877, xvii. 54.

DIDYMO'PRIUM, Kütz.—A genus of Desmidiaceæ.

Char. Cells with a bidentate or bicrenate process on each side, united into an elongated, fragile, cylindrical, and regularly twisted filament. (Sheath either present, wanting, or indistinct.)

Differs from *Desmidium* in having only two processes, and not being angular, and in the number of rays of the endochrome in the side view not depending upon the number of angles.

D. Borreri (Pl. 1. fig. 11). Joints inflated, barrel-shaped, longer than broad: side view circular; angles bicrenate. (Sheath wanting or indistinct.)

The delicate longitudinal lines were proposed by Jenner as a test-object for the power of the microscope; they are best seen in the empty cells when dried. Breadth of filament 1-1030″.

D. Grevillii (Pl. 14. fig. 5; fig. 6, side view). Joints broader than long, with a thickened border at their junction; side view broadly elliptic; angles bidentate. (Sheath distinct.) Breadth of filament 1-470″.

Bibl. Ralfs, *Brit. Desmid.* p. 55.

DIDYMOSPO'RIUM, Nees.—A genus of Melanconiei (Stylosporous Fungi), growing upon shoots of trees. The only British species, *D. profusum*, Grev., has very minute, oblong, uniseptate spores, at first glued together like a depressed conical nucleus, beneath the epidermis, afterwards bursting through and becoming free. *D. elevatum*, Lk. = *Melanconium bicolor*, Nees.

Greville's plant, however, has not truly uniseptate spores, and is rather a *Melanconium*, referred as a conidiiferous form by Tulasne to *Melanconium stilbostoma*.

Bibl. Berk. *Hook. Brit. Flor.* v. pt. 2. 357; *Ann. N. H.* 1840, vi. 438; Greville, *Sc. Crypt. Fl.* pl. 212. fig. 1 (as *Stilbospora*); Tul. *Carp.* ii. 120.

DIFFLU'GIA, Leclerc.—A genus of Rhizopoda, of the family Arcellina.

Char. Contained in a spherical or oblong, urceolate, incrusted carapace, from the anterior extremity of which are emitted variable numerous or multifid tentacular expansions. Freshwater.

The carapace is membranous, incrusted with minute grains of sand (and carbonate of lime?); in some it is covered with depressions or tubercles; these form the genus *Euglypha*, D. *D. Enchelys* forms gemmæ, and also resolves itself into four "spores."

Species very numerous.

D. proteiformis, E. (Pl. 30. fig. 39.) Carapace oval or almost spherical, covered with minute grains of sand; length 1-240".

D. oblonga, E. (*D. globulosa* (?), D.). Carapace oval, oblong, or rounded, smooth, brownish; length 1-200".

Bibl. Leclerc, *Mém. Muséum*, ii. 474; Ehr. *Inf.* 130; and *Berl. Ber.* 1840; Dujardin, *Inf.* 248; Schlumberger, *Ann. Sc. Nat.* 1845, iii. 254; Schneider, *Ann. N. H.* 1854, xiv. 332; Clap. & Lachm. *Inf.* 447; Lang, *Qu. Mic. Jn.* 1865, 285; Tatem, *M. M. J.* 1870, iv. 313; Archer, *Qu. M. J.* 1877, xvii. 115.

DIGLENA, Ehr.—A genus of Rotatoria, of the family Hydatinæa.

Char. Eyes two, frontal; foot forked.

There are no other appendages than the foot and the rotatory organ.

Nine species.

D. lacustris (Pl. 43. figs. 21, 22). Body oval, transparent, truncate in front; foot suddenly attenuate, somewhat more than 1-4th of the body in length; toes 1-3rd part of the foot in length; freshwater; length 1-70".

Bibl. Ehr. *Infus.* 441; Gosse, *Ann. N. H.* 1851, viii. 200.

DILEP'TUS, Duj.—A genus of Infusoria, fam. Trichodina.

Char. Body fusiform, prolonged anteriorly in the form of a swan's neck, with a lateral mouth at the base of the prolongation; entire surface covered with vibratile cilia, which are more distinct in front and near the mouth.

D. folium, D. (Pl. 30. fig. 40). Body very flexible, in the form of a lanceolate leaf, narrowed in front; with nodular, reticulated, irregular ribs; freshwater; length 1-160 to 1-120".

D. anser (*Amphileptus anser*, E.).

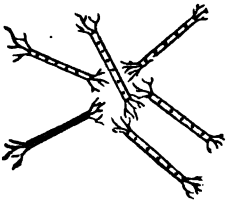
D. margaritifer (*Amphileptus marg.*, E.).

Dujardin separates these species from the genus *Amphileptus*, on account of their not possessing a reticulated integument, and their undergoing diffluence. Cl. & Lachm. unite them with *Amphileptus*.

Bibl. Duj. *Infus.* 404.

DILOPHOSPHORA, Desm.—A genus of Sphæronemei (Stylosporous Fungi), consisting of *Sphæria*-like plants (without asci), growing upon the leaf-sheaths and glumes

Fig. 177.



Dilophosphora graminis.
Spores. Magnified 800 diams.

of grasses; remarkable for the curiously appendaged spores (fig. 177).

D. graminis, Desm. = *Sphæria Alopecuri*, Fries. Sometimes very destructive to wheat-crops in the south of England.

Bibl. Desmazières, *Ann. Sc. Nat.* 2 sér. xiv. p. 4. pl. 1. fig. 2.

DIMASTIGOAU'LAX, Dies. = *Peridinium cornutum*, Ehr., *Ceratium c.*, Claparède & Lachmann. (Kent, *Inf.* 462.)

DIMEREGRAM'MA, Pritch.—A genus of Diatomaceæ.

Char. Frustules quadrangular, two or more together; valves (undulate, Rab.) with transverse costæ interrupted by a smooth longitudinal line.

Several species.

Bibl. Pritchard, *Inf.* 123; Grun. *Wien. Verh.* 1862; Gregory, *Diat. of Clyde*, 22; Rabenhorst, *Flor. Alg.* i. 123.

DI'MONAS, Kent.—A genus of Flagellate Infusoria.

Char. Free, ovate or pyriform; flagella 2, equal; mouth very dilatable.

Two species; in infusions, fresh and salt; hay. (Kent, *Inf.* 421.)

DIMORPHI'NA, D'Orb. — A hyaline Foraminifer, in which the early chambers have the alternate growth of a *Polymorphina*, and the later ones the linear arrangement of a *Nodosaria*. *D. tuberosa*, D'Orb.

Modèle no. 60, is the type of this dimorphous *Polymorphina*. Fossil and recent.

Bibl. Parker and Jones, *Ann. N. H.* ser. 3. xvi. 28; D'Orb. *For. Foss. Vien.* 221.

DIMORPHOCOCCUS, Braun.—A genus of Palmellaceous Algæ; consisting of free botryoidal substipitate groups of ovate or lunate green cells, 4 in each.

D. lunatus (Pl. 51. fig. 43). In pools; Germany.

Bibl. Braun, *Alg. Unicell.* 44.

DINEMASPO'RIUM, Lév.—A genus of Sphæronemei (Stylosporous Fungi), consisting of minute plants forming spots upon the leaves of grasses. *D. gramineum*, Lév., the only British species, = *Excipula graminis*, Berk. *Br. Fungi*, No. 328, and *Exc. gram.*, Corda. It has a scattered conceptacle, closed at first, and subsequently widely opened, forming a disk covered with white spores of a peculiar form, abruptly produced into filaments at each end (fig. 178).

Fig. 178.

Dinemasporium gramineum. Spores, magn. 600 diams.

Bibl. Berk. and Broome, *Ann. N. H.* 2 ser. v. 456; Léveillé, *Ann. Sc. Nat.* 3 sér. v.274; Corda, *Icon. Fung.* iii. pl. 5. fig. 79.

DINEMOU'RA, Latr.—A genus of Crustacea, belonging to the order Siphonostoma and family Pandaridæ.

Char. Lamellar elytriform appendages covering the thorax, only one pair. First three pairs of legs setiferous; the posterior foliaceous and membranous.

D. alata and *D. Lamnæ* have both been found upon the Beaumaris Shark (*Lamna monensis*).

Bibl. Baird, *Brit. Entomostr.* 282.

DINENYM'PHA, Leidy.—A genus of Holotrichous Infusoria.

Free, elongate, flexible, ciliated all over.

D. gracilis, in the intestines of white ants. (Kent, *Inf.* 555.)

DINOBRYI'NA, Ehr.—A family of Flagellate Infusoria.

Char. Bodies variable in form, with two flagella, one short, one long; contained in urceolate capsules, which are either single, or aggregated into a branched zoary from the new capsules remaining adherent by their bases to the summits or the bases of the preceding: the result of multiplication by gemmation; freshwater. (Astasiæa with a carapace.)

Two genera, *Dinobryon* and *Epipyxis*.

In *Dinobryon* an interior red eye-spot is present, but not in *Epipyxis*. In the former a flagelliform filament is present; this is sometimes met with in the latter, but not constantly.

Bibl. Ehr. *Inf.* 122; Duj. *Inf.* 320.

DINOB'RYON, Ehr.—A genus of Infusoria, of the family Dinobryina.

Char. Carapaces urceolate, united in the form of a branched polypidom.

D. sertularia, E. (Pl. 30. fig. 41). Carapaces sessile or subsessile, slightly constricted near the somewhat expanded and excised end; length of zoary 1-144 to 1-120″, of bodies 1-570″.

Hermann and Archer point out that the bodies become encysted at the mouth of the capsules, forming *Chlamydomonas*-like organisms.

Bodies yellow or green, with a red eye-spot in front.

D. sociale, E. Carapace conical, truncate.

D. gracile, E. Carapace slightly constricted in the middle.

D. petiolatum, D. (Pl. 30. fig. 42). Carapaces with long stalks, bodies green; length of the polypidom 1-100″, of a carapace 1-1420″.

Bibl. Ehr. *Infus.* 124, and *Berl. Ber.* 1840, 199; Duj. *Inf.* 321; Archer, *Qu. Mic. Jn.* 1866, 123; Kent, *Inf.* 409.

DINO'CHARIS, Ehr.—A genus of Rotatoria, of the family Euchlanidota.

Char. A single cervical eye; foot forked; carapace closed beneath, and without teeth at the ends.

Jaws with one (or two?) teeth each. Aquatic. Two horns at the base of the foot.

D. tetractis (Pl. 43. fig. 23; fig. 24, teeth). Carapace acutely triangular, two horns at the base of the foot, and two toes; length 1-120″.

Two other species.

Bibl. Ehr. *Infus.* 471.

DINO'PHYSIS, Ehr.—A genus of Flagellate Infusoria, of the family Peridinæa; marine.

Char. Free, single; carapace membranous, urceolate, with a transverse ciliated furrow, and a median plicate crest; no eye-spot.

Form, that of *Vaginicola*; nature, that of *Peridinium*. The transverse furrow is close to the truncated anterior end; and from this furrow there extends down the body a folded crest or fringe, like that of *Stentor*, except that it is a part of the carapace. A crown of

cilia exists around the neck, and a longer flagelliform filament. Carapace punctate.

D. norwegica; length 1-420″.

Eleven species, Kent.

The species are found in sea-water with luminous animals; probably themselves luminous.

Bibl. Ehr. *Berl. Abh.* 1839, 125, 151; Kent, *Inf.* 458.

DIO'PHRYS, Duj.—A genus of Infusoria, of the family Plœsconina.

Char. Body of irregular discoidal form, thick, concave above and convex beneath, with five large vibratile cilia at the anterior, and four or five very long geniculate setæ near the posterior end. Marine.

D. marina (Pl. 30. fig. 43: *a*, under view; *b*, side view). Body oval, with a longitudinal excavation; length 1-580″.

Bibl. Duj. *Inf.* 445; Clap. & Lachm. *Inf.* 406.

DIORITE. See Rocks.

DIOSAC'CUS, Boeck.—A genus of Copepoda (Entomostraca.)

One species; marine.

Bibl. Brady, *Copep.*, *Ray Soc.* ii. 68.

DIPHA'SIA, Agassiz.—A genus of marine Hydroid Zoophytes, family Sertulariidæ = *Sertularia*, pt.; comprising the species with the ovigerous vesicles cleft at the margin. 7 species.

Bibl. Hincks, *Brit. Zooph.* p. 244.

DIPHYSCIA'CEÆ.—A family of operculate Acrocarpous Mosses, having a capsule of very curious structure. The leaves are of two kinds, the cauline tongue-shaped, composed of perfectly Pottioid, densely hexagonal, parenchymatous cells filled with chlorophyll; the perichætial leaves much protruded, exceeding the cauline, composed of cells ultimately destitute of chlorophyll, therefore of looser texture. Capsule very large, oblique, gibbous, somewhat like that of *Buxbaumia*. Inflorescence monœcious. British genus:

DIPHYS'CIUM, Mohr.—Calyptra conical, covering the operculum. Peristome simple, internal, resembling that of *Buxbaumia*, surrounded at the base by a large multiplex, soluble annulus.

Bibl. Wilson, *Bryol. Brit.* 200; Berkeley, *Handb.* 214.

DIPLA'SIUM, Presl.—A genus of Asplenieæ (Polypodioid Ferns). Exotic.

DI'PLAX, Gosse.—A genus of Rotatoria, of the family Euchlanidota.

Char. Those of *Salpina*, except that the eye is wanting, and the carapace (which, as in that genus, is cleft down the back) is destitute of spines both in front and behind; foot and toes long and slender.

Forms a connecting link between *Salpina* and *Dinocharis*.

D. compressa. Carapace in side view forming nearly a parallelogram, greatly compressed; length 1-176″; freshwater.

D. trigona. Carapace trilateral; surface delicately punctured; length 1-160″; freshwater.

Bibl. Gosse, *Ann. N. H.* 1851, viii. 201.

DIPLOCO'LON, Näg.—A doubtful genus of Scytonemaceous Algæ.

D. Heppii. On calcareous rocks; Germany.

Bibl. Nägeli, *Nov. Act.* 1857; Rabenhorst, *Fl. Alg.* ii. 246 (fig.).

DIPLO'DIA, Fr.—A genus of Sphæronemei (Stylosporous Fungi), usually growing upon dead twigs &c., bursting through the epidermis. Numerous species have been described as British by Mr. Berkeley; but the resemblance of many to various *Sphæriæ* is remarked by him, and Tulasne states that they are only stylosporous forms of species belonging to that genus or its allies.

Bibl. Berk. *Ann. N. H.* vi. 365, pl. 11; 1850, v. 371; xiii. p. 459; Hook. *Jn. Bot.* iii. 320, v. 40; Léveillé, *Ann. Sc. Nat.* 3 sér. v. 290; Tulasne, *ibid.* xx. 136; *ibid.* 4 sér. v. 115.

DIPLODON'TUS, Dugès.—A genus of Arachnida, of the order Acarina, and family Hydrachnea.

Char. Mandibles terminated by a straight, acute, and immoveable tooth, to which is opposed a moveable hook or claw; palpi shortish, with the fourth joint longest and terminated by a point as long as the fifth joint; coxæ not very broad, in four separate groups, the posterior of which are semi-divergent; a bivalve, granulated, heart-shaped genital plate, the apex directed forwards.

D. scapularis (Pl. 6. fig. 30: fig. *a*, labium with a palp, under view; *b*, a separate mandible more magnified than *a*). Eyes very small, but projecting, wide apart, placed at the anterior rounded angles of the body, blackish and reniform, arising from the fusion of two stemmata. Anterior half of the body black, speckled with a few red spots; posterior half scarlet, but divided by a median longitudinal black band. Length of female 1-10″; male 1-3rd or 1-4th the size of the female.

D. filipes. Palpi much curved down-

wards, but little visible from above. Body elliptical, depressed, bright red, sometimes marbled with dark brown spots, from the digestive organs being visible through the integument. Eyes four, at the very anterior margin, so best seen from beneath. Integument finely granular, without hairs. Legs red. Length 1-25″.

D. mendax. Two clear longitudinal rays at the fore part of the body.

Bibl. Dugès, *Ann. Sc. Nat.* 2 sér. i. 148.

DIPLOMAS'TIX, Kent.—A genus of Flagellate Infusoria.

Char. Ovate, free, colourless, variable; flagella 2, one vibratile, the other trailing; mouth distinct.

Three species; salt and fresh water.

Bibl. Kent, *Inf.* 431.

DIPLO'MITA, Kent.—A genus of Flagellate Infusoria.

Char. Solitary, ovate, attached by a retractile filament to the base of a stalked horny lorica, flagella two, alike; eye-spot sometimes present; no mouth.

D. socialis. Brownish, length 1-1600″; pond-water.

Bibl. Kent, *Inf.* 289.

DIPLONE'IS, Ehr. = *Navicula* with the valves constricted in the middle.

DIPLOZO'ON, Nordm.—A genus of Trematode Entozoa.

Char. Body of individuals soft, elongated and flattened; united in pairs by their fusion near the middle, thus resembling an X; each body terminated posteriorly by a transverse, oval, or almost quadrilateral expansion, furnished with four suctorial disks. Mouth terminal, anterior, accompanied by two oblong suctorial disks.

D. paradoxum, the double animal. Found upon the gills of freshwater fishes, as the carp, the roach, the bream, &c. Length 1-6 to 1-5″, or twice this length.

The separate individuals (*Diporpa*, Dujardin) are smaller than those in a state of conjugation (length 1-100 to 1-45″), and contain no trace of reproductive organs. Ova formed in each individual after the conjugation; they are yellow, with the shell narrowed and prolonged into a filamentous spiral or coil.

Bibl. Nordmann, *Mikr. Beit.* 1832, i. 56; *Ann. Sc. Nat.* 1833, xxx.; Ehrenberg, *Wiegmann's Archiv*, 1835, ii. 128; Mayer, *An. d. Entoz.* 23; Siebold, *Sieb. u. Köll. Zeits.* iii. 62; Vogt, *Müller's Archiv*, 1841, 33.

DIPODI'NA, Ehr.—A genus of Rotatoria. Differs from *Notommata* by a particular constriction of its tarsal nippers or toes. At Wismar. (Pritchard, *Inf.* 713.)

DIPOR'ULA, Hincks.—A genus of Cheilostomatous Polyzoa.

D. verrucosa; Cornwall. (Hincks, *Polyzoa*, 220.)

DIP'TERA.—The seventh order of Insects, containing the "flies," &c.

DIRI'NA, Fr.—A genus of Lichenaceous Lichens, tribe Lecanorei.

D. ceratoniæ (fig. 26, p. 65).

D. repanda. Occurs in Jersey.

Bibl. Leighton, *Lich. Fl. G. B.* p. 226.

DISCELIA'CEÆ.—A family of operculate Acrocarpous Mosses, of gregarious habit, very dwarf and stemless, arising from a green prothallium spreading on the ground. The sheathing leaves are appressed, oblong, acuminate and nerveless, composed of cells lax at the base and apex, rhomboidally parenchymatous, destitute of chlorophyll, fuscescent and empty. Capsule subglobose and inclined, with a short collum, annulate and long-stalked. The antheridial and archegonial flowers are upon the same runner of the prothallium. British genus:

DISCE'LIUM, Brid.—Calyptra longish, very narrow, split almost to the summit, wider in the middle, with the margin involute on each side at the base. Peristome simple, of sixteen lanceolate teeth, fissile in the middle, trabeculate, striate, cartilaginous, reddish or orange.

Bibl. Wilson, *Bryol. Brit.* 286; Berkeley, *Handb.* 167.

DISCEL'LA, Berk. and Br.—A genus of Sphæronemei (Stylosporous Fungi), forming scattered, disk-like, dark spots upon twigs; at first covered by the epidermis, which afterwards splits and separates. Five species are described, occurring on the willow, lime, plane, and elder.

Bibl. Berk. and Broome, *Ann. N. H.* 2 ser. v. 376, pl. 12. fig. 8; Berkeley, *Outl.* 322.

DISCOCEPH'ALUS, E.—A genus of Infusoria, of the family Euplota.

Char. Head distinct from the body; hooks present, but neither styles nor teeth.

D. rotatorius (Pl. 30. fig. 44). Hyaline, flat, rounded at each end; head narrower than the body; length 1-380″. Red Sea. Imperfectly examined.

Bibl. Ehr. *Infus.* p. 375.

DISCOMYCE'TES.—The name of one of the families of Fungi under Fries's classification, including the Helvellacei and Phacidiacei of the Ascomycetes.

DISCOPLE'A, Ehr.—A genus of Diatomaceæ, not now retained, the species being referred to the genera *Cyclotella* and *Coscinodiscus*. Ehr. *Ber. Berl. Ak.* 1844, p. 197.

DISCORBI'NA, Parker and Jones.—One of the *Rotalinæ*, having a turbinoid spire, with vesicular chambers, opening one into another by slit-like apertures, which are usually tented over by a succession of umbilical flaps, forming a star-like ornament (see ASTERIGERINA). The shell is usually coarsely, sometimes finely, and occasionally partially porous. Fossil and recent. *D. rosacea* (Pl. 24. fig. 7 *a*, *b*) is a neat variety of *D. turbo*.

BIBL. Carpenter, *Introd. Foram.* 203.

DISCO'SIA, Libert.—A genus of Sphæronemei (Stylosporous Fungi), probably related to some of the *Sphæriæ*, as stylosporous forms. The species have been described under various names; and the genus *Phlyctidium* of Notaris is synonymous with it. The British species recorded seem to have been greatly confused by different writers; for *Discosia alnea*, Libert, found on the leaves of alder and beech, = *Sphæria artocreas*, Tode, *Xyloma fagineum*, Pers., *Phlyctidium nitidum*, Wallr., *Ph. clypeatum*, Notaris, and, from its name, we conclude also *Dothidea alnea*, Pers. of Hook. *Brit Flor.*, with its synonyms. Fries, in his *Summa Veget.*, gives *D. artocreas*, *alnea*, and *clypeata* as three distinct species.

BIBL. Léveillé, *Ann. Sc. Nat.* 3 sér. v. 286; Fries, *Sum. Veget.* 423; Fresenius, *Beitr. z. Mycol.* Heft i. 66, pl. 8; De Notaris, *Mem. Accad. Torino*, 1849, 2 ser. x.; Berk., *Hook. Br. Fl.* 278, 288.

DISCOSIRA, Rab.—A genus of Diatomaceæ.

Char. Frustules disk-shaped, concatenate; valves nearly plane, with curved costæ; margin denticulate; centre delicately punctate.

D. sulcata. Italy.

BIBL. Rabenhorst, *Flor. Alg.* i. p. 36.

DISEL'MIS, Duj. = CHLAMIDOMONAS, Ehr. (*Chl. pulvisculus*, F. = *Diselmis viridis*, D.; Pl. 7. fig. 2 *b*, *c*.; Pl. 30. group 30). See PROTOCOCCUS.

Dujardin describes a marine species, *D. marina*. Body almost globular, obtuse and rounded in front, granular within, and (from generic characters) with a non-contractile tegument and two similar cilia.

He adds to this genus *D. Dunalii* = *Monas Dunalii*, Joly, giving rise to the red colour of the reservoirs of the salt-works of the Mediterranean; oval or oblong, often constricted in the middle; colourless when young, greenish when older, red when adult; no eye-spot.

Probably marine Algæ.

BIBL. Dujardin, *Inf.* 340; Joly, *Hist. d'un Petit Crustacé &c.* 1840.

DISIPHO'NIA, Ehr.—*D. australis* (Pl. 51. fig. 16) = *Diatomella*, pt.

DISO'MA, Ehr.—A genus of Infusoria, of the family Enchelia.

Char. Body double, not ciliated; mouth without teeth, ciliated and truncated (= *Enchelys* with a double body).

D. vacillans (Pl. 30. fig. 45). Segments clavate, filiform; hyaline and narrowed at the anterior end; length 1-380 to 1-288″. In the Red Sea.

BIBL. Ehr. *Infus.* 302.

DIS'SODON, Grev. and Arnott.—A genus of Splachnaceæ (Acrocarpous operculate Mosses), including some *Splachna* of authors and a *Cyrtodon*.

BIBL. Wilson, *Bry. Brit.* 295; Berkeley, *Handb.* 163.

DISTEM'MA, Ehr.—A genus of Rotatoria, of the family Hydatinæa.

Char. Eyes two, cervical; foot forked.

D. forficula (Pl. 43. fig. 25; fig. 26, teeth). Body cylindrico-conical; eyes red; toes strong, recurved, toothed at the base; fr. water; length 1-120″.

Three other species, two of which are freshwater, and one marine. In the latter, *D. marina*, the cervical eye-spots are colourless; if these do not really represent eyes, this species must be referred to the genus *Pleurotrocha*.

BIBL. Ehr. *Infus.* p. 449.

DISTICHIA'CEÆ.—A family of operculate Acrocarpous (terminal-fruited) Mosses, of cæspitose habit; the stem increasing towards the point, simple or branched; the leaves with a dorsal keel-like nerve, equitant-concave, densely imbricatively overlapping, parenchymatously areolated. Cells minute, with thick walls, somewhat papillose, very densely packed, squarish. Capsules oval, equal. British genus:

DISTIC'HIUM, Br. and Schimper.—Calyptra dimidiate. Capsule annulate. Peristome simple, with sixteen equidistant teeth, free at the base, once or several times slit from the base to the apex, trabeculate, deep purple, homogeneous, smooth or rough. Inflorescence monœcious.

BIBL. Wilson, *Bry. Brit.* p. 104; Berkeley, *Handb.* p. 266.

DISTIG'MA, Ehr.—A genus of Infusoria, of the family Astasiæa.

Char. Unattached, two blackish eye-spots.

Flagelliform filaments two, one long, one short; motion similar to that of a leech. Body variable in form; freshwater.

D. proteus (Pl. 30. fig. 46 *a*). Body hyaline, obtuse at the ends, alternately contracted or expanded from side to side; eye-spots distinct; length 1-570 to 1-430″.

D. viride (Pl. 30. fig. 46 *b*). Body filled with green granules, alternately contracted and expanded; eye-spots distinct; length 1-570″.

Two other species; one yellow, the other colourless.

Bibl. Ehr. *Infus.* 116; Kent, *Inf.* 418.

DIS'TOMA, Gærtn.—A genus of Mollusca, of the order Tunicata, and family Botryllidæ.

Distinguished by the sessile, semicartilaginous, polymorphous mass; the numerous circular systems; the individuals in one or two rows at unequal distances from a common centre, with thorax and stalked abdomen; and the branchial and anal orifices six-rayed. On marine Algæ (*Fucus &c.*).

D. rubrum (Pl. 36. fig. 23). Mass red, individuals yellowish; 5″ in diameter, ½″ thick.

D. variolosum. Reddish- or yellowish-white; bodies orange-red.

Bibl. Forbes and Hanley, *Br. Moll.* i. 18.

DISTOMA, Zeder, or *Distomum.*—A genus of Entozoa, of the order Sterelmintha, and family Trematoda.

Char. Body soft, depressed or cylindrical, more or less elongated, not jointed, brown; furnished with two distinct suckers—one anterior, terminal, and containing the mouth, the other situated on the ventral surface between the former and the middle of the body.

Species very numerous; Dujardin describes 164; most common in birds and fishes, generally inhabiting the alimentary canal. Each *Distoma* has its separate *Cercaria*, which live in as many distinct animals.

D. hepaticum (the fluke) occurs in the gall-bladder and hepatic ducts of sheep when affected with the 'rot'; it occurs also in the horse, the ox, the goat, the hare, the stag, and in man. The intestine is two-branched, and the branches ramified. Length 4-5 to 1½″.

D. hepaticum is of special interest, on account of the immense destruction it causes of sheep. When the young *Distoma* leaves the ovum, it resembles an obconical ciliated Infusorium, with a short terminal proboscis; the cilia are subsequently cast off, and a sporocyst or *Redia* is formed, which attaches itself to Mollusca, and in which numerous *Cercariæ* are then produced. These when liberated, swim in water, and are swallowed by sheep, or the mollusca containing them are eaten with the grass; and so the young *Distomata* enter the alimentary canal, to take up their final abode in the biliary ducts.

D. lanceolatum has the intestine once branched, then simple; it occurs in the liver of man, the ox, the sheep, the pig &c.

D. (*Bilharzia*) *hæmatobia*, the African Trematode, has the body vermiform; the male ½″, the female 1″ long. It is found in the bloodvessels of man in Egypt, Mauritius, South Africa, &c.

D. sinensis occurs in the liver of the Chinese.

Some of the species are microscopic.

Bibl. Dujardin, *Helminth.* 381; Beneden, *Ann. Sc. Nat.* 3 sér. *Zool.* xvii.; Cobbold, *Parasites*, 1879, xiv.; Bowles, *Sheep-rot*; *Times* (*remedy*) Apr. 10, 1881; *Ann. N. H.* 1880, vi. 405; Sommer, *Anat.* 1880.

DIT'IOLA.—A genus of Tremellini (Basidiomycetous Fungi) consisting of saucer-shaped margined gelatinous Fungi, with a discoid hymenium, which is at first veiled. *Ditiola radicata* occurs rarely in this country on decayed firwood. *D. nuda*, B. and Br., is considered by Tulasne synonymous with *Dacrymyces deliquescens.*

Bibl. Alb. & Schwein. pl. 8. f. 6; Berk. *Outl.* p. 291.

DOCH'MIUS, Duj.—A genus of Nematoid Entozoa.

D. (*Anchylostoma*) *duodenalis* is filiform, the head pointed and curved; the mouth with four unequal converging curved teeth; body pointed behind in the female, blunt in the male; viviparous; length of male ⅜″, of female ½″. Occurs in the human small intestines, in Italy, Austria, Egypt, and South America, producing anæmia and chlorosis.

D. trigonocephalus, in the dog.

D. Sangeri, in the elephant.

Bibl. Dujardin, *Helm.* 275; Cobbold, *Paras.* 211 (fig.).

DOCID'IUM, Brébisson.—A genus of Desmidiaceæ.

Char. Cells single, straight, much elongated, linear, sometimes attenuated towards the ends; constricted in the middle, ends truncate; segments usually inflated at the base.

Rabenhorst includes the species in *Pleurotænium.*

Docidium, like *Closterium*, has the terminal spaces with moving molecules; and its vesicles are either scattered or arranged in a single longitudinal row.

D. truncatum (Pl. 14. fig. 38). Segments three or four times as long as broad, with a single inflation at the base; suture projecting on each side; length 1-80 to 1-72″.

D. baculum (Pl. 14. fig. 39). Segments very slender, with a single conspicuous inflation at the base, otherwise linear; vesicles in a single series; length 1-111″.

D. nodulosum. Segments four to six times as long as broad, constricted at regular intervals so as to produce an undulated margin; suture projecting; length 1-50″.

Several other species.

BIBL. Ralfs, *Desmid.* 155; Pritchard, *Infus.* 744; Rab. *Fl. Alg.* iii. 141; Hobson, *Qu. Mic. Jn.* iii. 1863, 169 (Bombay).

DOCOPH'ORUS, Nitzsch.—A subgenus of *Philopterus* (Anoplura), distinguished by the small moveable tooth or trabecula in front of the antennæ, and the dark lines running from them to the occiput.

D. communis (Pl. 35. fig. 5). On Insessores.

D. icterodes. Common on ducks and geese.

DOLICHOSPER'MUM, Thwaites (Pl. 8. fig. 6).—A genus of Nostochaceæ, allied to *Trichormus, Sphærozyga*, &c., established by Thwaites for five British species, from which Hassall has separated one under the name of *Coniophytum.* Thwaites noticed in this genus that the contents escaped in an undivided mass from the elongated and mostly cylindrical spermatic cells (sporanges), which are invariably truncated at the ends.

D. inæquale, Ralfs. Filaments moniliform; ordinary cells at first quadrate, finally orbicular; vesicular cells large, spherical; sporanges linear, catenate (Ralfs, *Ann. N. H.* 2 ser. v. pl. 9. fig. 1). Forming extensive strata, composed of thick gelatinous masses of a deep green colour, on boggy pools; filaments consisting of 100 to 200 cells.

D. Ralfsii (Kützing). Filaments moniliform; ordinary cells spherical; vesicular cells elliptic; sporanges elliptic or cylindrical, one or two in each series. Ralfs, *l. c.* pl. 9. fig. 2; *Sphærozyga Ralfsii*, Thwaites, Harvey's *Algæ*, 2 ed. 233. *Cylindrospermum Ralfsii*, Kützing, *Tab. Phycol.* i. pl. 98. fig. 7. Forming extensive strata of a velvety rich dark green colour, sometimes verging towards æruginous green, on rivulets and in bogs.

D. Smithii, Thwaites. Filaments straight, each included in a definite gelatinous sheath; ordinary cells subspherical, compressed, about as long as wide; vesicular cells subspherical, somewhat barrel-shaped, half as wide again as the ordinary cells, puncta very distinct; sporanges cylindrical, very unequal in length, and with the ends rounded and somewhat truncated. Ralfs, *l. c.* pl. 9. fig. 4. Freshwater boggy pools.

D. Thwaitesii, Ralfs. Filaments straight, or nearly so; ordinary cells quadrate; vesicular cells oblong, subquadrate, puncta very distinct; sporanges numerous, cylindrical, with truncated ends, very variable in length (Ralfs, *l. c.* pl. 9. fig. 5). *Sphærozyga Thw.* Harvey, *Br. Algæ*, 2. 232. Freshwater or brackish pools. (*D. Thompsoni*, Ralfs, see CONIOPHYTUM.)

DOMOP'ORA, D'Orb.—A genus of Cyclostomatous Polyzoa, = *Tubulipora*, pt., Johnstone.

2 species; deep water. (Hincks, *Pol.* 481.)

DONKIN'IA, Ralfs.—A genus of Diatomaceæ, = *Amphiprora* with decussating striæ, but without alæ to the valves.

Pritchard describes 7 species. Rabenhorst describes 4 European, and enumerates 12 extra-European species.

BIBL. Pritchard, *Infus.* 920; Rabenh. *Flor. Alg.* i. 242.

DOO'DIA, Brown.—A genus of Blechneæ (Polypodiaceous Ferns). Exotic.

DORIP'YGUS, Brady.—A genus of Copepodous Entomostraca.

Four species; inhabitants of the branchial sacs of simple Ascidians. (Brady, *Copep.*, *Ray Soc.* i. 132.)

DORYPH'ORA, Kütz. — A genus of Diatomaceæ.

Char. Frustules single, stalked; valves orbicular-lanceolate or broadly elliptical, with a median longitudinal line, but no nodules. Marine.

The valves are furnished with transverse or slightly radiating rows of dots.

D. amphiceros, K. (Pl. 16. fig. 29: *a*, side view of frustule; *b*, front view; *c*, prepared valve.) Valves orbicular-lanceolate or

broadly elliptical, ends produced; length 1-500 to 1-800″.

D. Boeckii, S. (*Cocconema B.*, K.). Valves elongato-lanceolate, ends somewhat obtuse; length 1-144″. This species appears to have a median and terminal nodules.

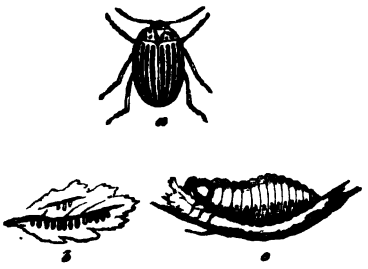
Bibl. Kützing, *Bacill.* 74, *Sp. Alg.* 50; Smith, *Diatom.* i. 77; Rabenhorst, *Fl. Alg.* i. 126 (*Raphoneis*).

DORYPH'ORA, Illiger.—A genus of Subpentamerous (Tetramerous, Latr.) Coleoptera, fam. Chrysomelidæ.

The very numerous species are found in equinoctial America. The thorax or mesosternum is armed with a long point, projected forwards.

D. decemlineata (fig. 178*) is the Colorado

Fig. 178*.



Doryphora decemlineata. *a*, natural size; *b*, eggs; *c*, larva.

potato-beetle. It is of an orange-yellow colour, each elytrum being marked with 5 longitudinal, dark rough-edged striæ. The eggs are yellow, and attached to the under side of the leaves of the potato, to which plant the hatched larvæ have proved so extremely destructive in America, as to have annihilated entire crops. The beetle has been brought over to this country by ship, but has fortunately not become diffused and naturalized.

An Order in Council prohibits the keeping of these beetles alive, under a severe penalty.

DOTHID'EA, Fries.—A genus of Sphæriacei (Ascomycetous Fungi), often growing upon leaves. Distinguished from *Sphæria* and the more closely allied genera by the asci being contained in cavities in the stroma, without any distinct perithecium. Numerous species are described as British by Berkeley, some of which are now placed under other genera by himself and Fries: thus *D. Geranii, Robertiana, Ranunculi, Potentillæ* and *Alchemillæ* of the *Brit. Flora*, and *D. Chætomium*, Kze., are species of Stigmatea in the *Summa Veg.*; *D. alnea* is removed to Discosia, and *D. pyrenophora* and *sphæroides* are placed under Dothiora, Fries, a stylosporous form. The whole of these plants require further study, since it is probable that they are really connected with the Sphæronemei or Melanconiei; for Berkeley's observations go to show that *Asteroma Ulmi* is a form of *Dothidea Ulmi*, while Tulasne has found upon *Dothidea Ribesii* spores or spermatia like those of *Xylariæ*, others in excavated cavities having the character of the spores of *Septoria*, while in ordinary cases the surface is covered with conceptacles filled with eight-spored asci.

Bibl. Berk. *Br. Fl.* ii. pt. 2. 285; *Ann. N. H.* vi. 364; Berk. and Br. *Ann. N. H.* 2 ser. ix. 385; Fries, *Summa Veget.* 386, 418 & 421; Corda, *Ic. Fung.* iv. 119; Tulasne, *Ann. Sc. Nat.* 4 sér. v. 118.

DOTHIORA, Fries. See Dothidea.

DOXOCOC'CUS, Ehr.—A genus of Infusoria, of the family Monadina.

Char. No tail; no eye-spot; motion that of an irregular kind of rolling-over.

D. ruber (Pl. 30. fig. 47 *a*, after Ehr.). Body globose, brick-red, more or less opaque; breadth 1-1728″; freshwater.

This organism is almost beyond doubt the same as that represented in Pl. 30. fig. 24, *d* and *f* (*nobis*), *i. e.* a form of *Trachelomonas volvocina* (Trachelomonas). This was suspected by Ehrenberg.

D. pulvisculus, E. (Pl. 30. fig. 47 *b*), is probably an early stage of the same.

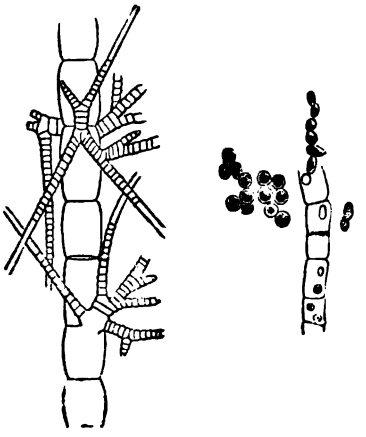
The other two species—*D. globulus*, subglobose or ovate, hyaline, marine, breadth 1-864″; and *D. inæqualis*, subglobose, unequal, hyaline, speckled with green; freshwater; breadth 1-2400″ — are probably Algæ, or their spores.

Bibl. Ehr. *Infus.* p. 28.

DRAPARNAL'DIA, Bory.—A genus of Chætophoraceæ (Confervoid Algæ), especially distinguished (as limited here in accordance with Kützing) by the filaments being composed of an axis of cells of much greater diameter than that of the tufted cells forming the branches (fig. 179). The species placed here by Hassall and others, devoid of this character, will be found under Stigeoclonium. The green contents of the cells form a broad band in the middle of the cell. These plants are propagated by 4-ciliated zoospores, formed from the contents of the cells of the branches (fig. 180);

and by resting-spores formed in the same situation and set free by the solution of the walls.

Fig. 179. Fig. 180.



Draparnaldia glomerata.

Fig. 179. Portion of a filament. Magnified 200 diams.

Fig. 180. Portion of a branch discharging zoospores from its cells. Magn. 400 diams.

D. glomerata, Ag. (fig. 179). Principal filament about 1-800″ in diameter, irregularly branched; ramelli 1-2400 to 1-3000″, in ovate tufts, generally alternate, and patent. Hassall, *Alg.* pl. 13. 1; *Engl. Bot.* 1746; Vauch. *Conferves*, pl. 12. fig. 1. Common in streams and wells.

D. plumosa, Ag. Principal filaments somewhat pinnately branched, size about the same as the preceding ramelli, in linear-lanceolate tufts, mostly approximated to the axis (Vauch. pl. 11. fig. 2; Kützing refers Hassall's *plumosa*, *l. c.* pl. 12. fig. 1, to *D. opposita*, Ag. as doubtful). Common in streams and wells.

D. repetita, Hass. Principal filaments composed of repeated series of cells, each series consisting of five or six cells, diminishing in size from the lowest to the highest, the series adjoining each other obliquely; tufts of ramelli dense, alternate. Hass. *l. c.* pl. 12. fig. 2. Rare.

See STIGEOCLONIUM.

BIBL. Bory, *Ann. Muséum*, xii.; Vaucher (as *Batrachospermum*), *Conferves d'Eau douce*; Link (as *Charospermum*), *Hor. Phys.* iii.; Hassall, *Algæ*, 118; Decaisne, *Ann. Sc. Nat.* 2 sér. xvii. 314; Thuret, *ibid.* 3 sér. xiv. 15; Currey, *Qu. Mic. Jn.* vi. 207, pl. 9; Hicks, *ibid.* 1869, 383; Rabenhorst, *Fl. Alg.* iii. 381.

DREPANOS'IPHON, Koch.—A genus of Aphidæ.

D. platanoides, and *D. acerina*, on the sycamore. (Buckton, *Aphid., Ray Soc.* i. 182.)

DRI'MYS, Forst.—A genus of Magnoliaceæ (Dicotyledonous Plants), remarkable for the microscopic structure of the wood. See WINTEREÆ.

DRY ROT.—A peculiar decay in wood, caused either by the presence of Fungi, as *Merulius lacrymans* and *Thelephora pateana*, or by a chemical process known under the name of Eremacausis or gradual combustion. Many remedies have beeen proposed; sulphate of copper, corrosive sublimate and creosote, especially the latter, are amongst the most approved. In domestic architecture, a free circulation of air and exclusion of moisture are essential.

DRYMOGLOS'SUM, Presl.—A genus of Grammitideæ (Polypodiaceous Ferns). *D. cornosum*, exotic.

DUCTS.—A term applied in structural botany to those forms of the so-called vascular tissue which consist of long tubes constructed out of perpendicular rows of cells, which are thrown into one by the absorption of their adjoining ends. Ducts are thus easily distinguished from vessels, which taper off to closed ends, by the constrictions upon the walls of the tubes, indicating the junctions of the component cells (fig. 181). See TISSUES, VEGETABLE; and VESSELS.

Fig. 181.

Dotted duct from the Melon. Magn. 250 diams.

DUDRESNAI'A, Bonnem.—A genus of Cryptonemiaceæ (Florideous Algæ), containing two minute British species, with delicate, branched, filiform fronds, a few inches high, of rose-red or reddish-brown colour. *D. coccinea*, which is a very rare plant, and seldom found except on the south coasts of England and Ireland, and *D. Hudsoni*, a not uncommon sea-weed, present very elegant microscopic structure, the fronds being composed of a central cellular axis, clothed with tufts of delicate, dichotomous, moniliform filaments, standing perpendicularly upon it. The fructifying process in this genus is very complicated.

Bibl. Harvey, *Brit. Alg.* 154, pl. 21 C; *Phyc. Brit.* pls. 110, 244; Sachs, *Bot.* 294.

DUFOU'REA, Ach.—A genus of Lichens. *D. madreporiformis* occurs in Switzerland and Germany.

DUMON'TIA, Lamx.—A genus of Cryptonemiaceæ (Florideous Algæ), containing one British species, *D. filiformis*, having a delicate tubular frond, of yellowish, greenish, or purple colour, of variable length and diameter, with numerous filiform branches, which are long on short fronds, and short on long fronds; growing commonly on rocks &c. between tide-marks. The wall of the tube is composed of a double layer of tissue, the outer of roundish cells, the inner of longish cells forming filamentous rows. The *spores* are attached in clusters to the internal wall of the tube (which is filled up with gelatinous substance), while the tetraspores are found among the surface-cells.

Bibl. Harvey, *Brit. Alg.* 147, pl. 20 *a*; *Phyc. Brit.* pl. 59; Greville, *Alg. Brit.* pl. 17.

DYEING. See Staining.

DYSPONTIUS, Thorell.—A genus of Copepodous Entomostraca.

D. striatus, in dredgings. (Brady, *Copep.*, *Ray Soc.* iii. 65.)

DYSTE'RIA, Huxley.—A genus of Hypotrichous Infusoria, fam. Ervilina. Distinguished by the valves of the carapace being united behind, but below only. Marine; five species.

Bibl. Huxley, *Qu. M. Jn.* 1857, 78; Cl. & Lachm. *Inf.* 284.

DYSTERI'NA, Cl. & Lachm. = *Ervilina*.

DYTIS'CUS, Linn., or *Dy'ticus*, a genus of Coleopterous Insects of the family Dytiscidæ.

Characters of the family: antennæ long and slender; external lobe of maxillæ articulated; anterior pair of legs shorter than the posterior pairs, which are flattened and fringed with hairs. Freshwater.

The genus *Dytiscus* is characterized by the first three joints of the anterior tarsi in the male being very large, and expanded into a patella or shield; the didactyle claws; and the maxillary palpi having the second and third joints of equal length.

The species of *Dytiscus* are of large size; *D. marginalis* is common in ponds and pools.

The head is well adapted for the display of the trophi, or organs of the mouth. Labrum transverse; mandibles short and robust, with a strong internal tooth; maxillæ short, flat, and ciliated internally, with the tip acute, the outer lobe palpiform: the true maxillary palpi about twice as long as the maxillæ; mentum transverse, with the sides produced into two lobes; labium short and square, palpi about twice its length, and three-jointed. The structure of the anterior tarsi in the male is very curious (Pl. 34. fig. 6 *a*), the three basal joints being expanded laterally so as to form a broad and rounded patella or shield, convex above, and covered beneath with a number of suckers or disks of various sizes, some of which are stalked (fig. 6 *b*. a small one). This structure enables the male to retain his hold upon the back of the female, the elytra of the latter being furrowed longitudinally, to aid in this effect. The three basal joints of the tarsi of the middle pair of legs are also flattened beneath, and covered with the stalked disks.

Fig. 182.

Dytiscus latissimus. Natural size.

Full-grown larvæ about two inches in length; of a dark ochre or dirty brown colour; the body long, subcylindrical, and eleven-jointed; the two terminal joints long and conical, the sides of the apex fringed with hairs. Terminal segment furnished with a pair of long and slender pilose appendages, by means of which the insect can suspend itself at the surface of the water; these are tubular, and communicate with the tracheæ of the body. Head (Pl. 35. fig. 14) large, oval, or rounded, depressed, and with five or six small elevated tubercles near the anterior angles representing the eyes (fig. 14 *a*). Two rudimentary, slender, seven-jointed antennæ (*b*) are inserted in front of the eyes. The mouth

has no aperture; the food, consisting of the juices of the prey, passes through a canal traversing the long, sickle-shaped, acute mandibles (*c*). Maxillæ (*d*) slender, cylindrical, and terminated by a short lateral spine; the maxillary palpi (*e*) are of the same thickness, arising from the tip of the maxillæ, and seven-jointed. Labial palpi (*f*) slender and four-jointed, the first and third joints being very short.

The head of the larva, and the three pairs of legs of the perfect insect, are commonly mounted as microscopic objects, as are those of other genera belonging to the family—*Acilius* &c.

Bibl. Westwood, *Introd.* &c. i. p. 95; Stephens, *Brit. Beetles.*

E.

ECCRI'NA, Leidy.—See Enterobrys.

ECHINEL'LA, Acharius.—A term applied first to a group of ova of some aquatic animal, next to a genus of Infusoria, more recently to a genus of Diatomaceæ, but now no longer used.

ECHINOBO'TRYUM, Corda.—A doubtful genus of Torulacei (Coniomycetous Fungi). *E. atrum* has been found in Britain, parasitic upon a species of *Pachnocybe.*

Bibl. Berk. and Broome, *Ann. N. H.* 2 ser. v. 460; Corda, *Icon. Fung.* ii. fig. 6.

ECHINOCOC'CUS, Rud.—A supposed genus of Entozoa, of the order Cestoidea and family Cystica; now shown to consist of the larvæ of Tænia.

Char. Consisting of a vesicle of very variable size, sometimes surrounded by a coat of condensed areolar tissue, and containing within, one or more secondary cysts; attached to the walls of these cysts, or suspended in their liquid contents, are numerous oblong, rounded, or oval bodies (scolices), each with four suckers, and a double crown of hooks.

E. veterinorum, the larva of *Tænia echinococcus* (Pl. 21. figs. 1 & 2), occurs in the liver, the cavity of the abdomen, the heart, the voluntary muscles, and the ventricles of the brain of man; in the liver, lungs, &c. of the ox, sheep, goat, ape, pig, &c. Commonly called hydatids. The walls of the brood-cysts consist of numerous concentric layers or plates, resembling those of colloid cells or cysts. The liquid existing within the cysts is yellowish or reddish, albuminous, and frequently contains plates of cholesterine, and crystals of bilifulvine (Pl. 13 fig. 15) (see Bile); some of the latter resemble in form and colour those of Hæmatoidine. The scolices appear to the naked eye as minute, white, opaque specks, varying in size from about the 1-300 to 1-100″ in length. They also vary greatly in form; when the head is retracted (fig. 1 *a*) they appear more rounded than when this is protruded (fig. 1 *c*, 1 *d*, 1 *f*). The hooks surrounding the anterior end of the body (fig. 1 *b*) consist of a broadish basal portion, an internal transverse blunt tooth, and a curved terminal portion or claw; they are about the 1-1500 to 1-1000″ in length. In some of the scolices a kind of pedicle exists at the base, by which they are attached to the wall of the cyst (figs. 1 *a* and 1 *c*); sometimes two or more lines may be perceived, running from the head towards the pedicle, and connected in front by a transverse line —probably representing vessels (fig. 1 *c*). Interspersed through the substance of the body are minute highly refractive corpuscles, containing carbonate of lime.

In the quite recent state, the scolices have been seen swimming actively in the liquid of the cyst; this motion is produced by cilia existing upon the surface of the body. Mingled with the perfect scolices are generally found some in which neither hooks nor suckers are visible, and in which the form is very irregular; some of these assume the natural form when treated with acetic acid.

The scolices appear usually to be developed by gemmation from the interior of the cysts; but, as Kuhn long since showed, they are sometimes produced by external gemmation (fig. 2): the contents produce a slight protrusion of a part of the wall of the cyst; the protruded portion enlarges, afterwards becoming constricted at its base, at last probably separating from the parent, to become itself a parent in the same manner. The example figured in Pl. 21. fig. 2 was not isolated; there were many, contained with numerous other larger cysts, of the most varied sizes, all in one very large parent cyst.

The *Echinococci* do not attain their full development into *Tæniæ*, unless they reach the alimentary canal. The cysts and their contents, including the *Echinococci*, sometimes undergo a kind of degeneration, be-

coming partially converted into fatty or calcareous matter; or the entire contents become amorphous and granular, the hooks remaining longest unaltered, but finally disappearing also.

See TÆNIA.

BIBL. Kuhn, *Ann. Sc. Nat.* 1 sér. xxix. 273; Siebold, *Wiegm. Archiv*, 1845, ii. 241, and *Siebold und Kölliker's Zeits.* iv.; Dujardin, *Helminth.* 635; Cobbold, *Paras.* 112.

ECHINODERMATA. — A Subkingdom in the Animal Kingdom, including the star-fishes (*Asterias*), the sea-hedgehogs or sea-eggs (*Echinus*), the sea-slugs (*Holothuria*), &c.

The Echinodermata are marine animals, with a coriaceous or calcareous integument; alimentary canal distinct, suspended in the cavity of the abdomen, and with either one or two orifices; distinct organs of circulation and respiration; sexes usually distinct, and external generative organs never present; disposition of organs generally quinary; body usually radiate or globose, sometimes cylindrical; nervous system forming a ring generally surrounding the mouth and giving off radiate branches.

A cutaneous skeleton usually exists as a network of calcareous corpuscles (Pl. 45. fig. 1), or numerous calcareous plates pretty regularly perforated so as to form a solid continuous network (Pl. 45. fig. 2). The plates are sometimes moveable, at others connected by sutures; some are perforated with larger apertures—the ambulacral pores; they are often furnished with calcareous appendages, tubercles, prickles, spines, hooks, &c., some being imbedded in the leathery integument itself. Many of these appendages, as well as the calcareous corpuscles, form beautiful microscopic objects, and possess very remarkable analytic power (see ECHINUS, SYNAPTA, and SHELL); they are also of importance in classification.

The muscular system consists of distinct flattened primitive fibrils and bundles, not transversely striated. The organs of locomotion exist in the form of little tentacle-like organs, the so-called feet or ambulacra. These are very contractile hollow prolongations of the cutaneous surface, expanded at the end, and connected by the ambulacral pores with contractile sacs (the ambulacral vesicles) placed on the inner surface of the leathery or calcareous covering of the body; they act as organs of adhesion and as feelers.

In the Echinidea (*Echinus*-family) and Asteridea (*Asterias*-family), other curious appendages occur, called *pedicellariæ* (Pl. 45. fig. 3); they are met with all over the cutaneous surface, and consist of a forcipate or valvular apparatus, acting as organs of prehension. The *pedicellariæ* of the Asteridea usually consist of two or three forceps-like or two broad valvular arms, and have hence been divided into forcipate and valvate *pedicellariæ*. They are mostly without a stalk. In the Echinidea (*Echinus*) they are most numerous around the mouth, and have been subdivided, according to their form, into:—1. Gemmiform, having three short lentil-shaped arms; 2. Tridactyle, having three long and laterally toothed arms; and 3. Ophiocephalous, with three spoon-shaped laterally toothed arms. These *pedicellariæ* contain a reticular calcareous mass as a basis, and in *Echinus* are placed upon a stalk, the lower portion of which encloses a calcareous nucleus, whilst the other portions are soft, extensile, and spirally retractile. The *pedicellariæ* of *Echinus*, which are partially covered with ciliated epithelium, can seize larger or smaller bodies, and pass them from one to the other; so that an object grasped by one of them situated on the posterior half of the body, or near the anal region, can be gradually passed on towards the mouth.

The abdominal cavity of the Echinodermata is always filled with sea-water, kept in motion by cilia covering the intestinal canal.

A true blood-vessel system, as well as the water-vessel or ambulacral system, is also present, into the structure of which and other particulars we have no space to enter.

In their youngest state, the Echinodermata consist of infusoria-like bilateral beings, without organs, and swimming by means of cilia on the surface.

BIBL. Siebold, *Vergl. Anat.* 74; Sharpey *Cycl. Anat. & Phys.* ii. 30; Agassiz, *Echinod. viv. et foss.*; Valentin, *Echinoderm*; Forbes, *Br. Starfishes*; Müller and Troschel, *Asteriden*; Müller, *Berl. Abh.* 1846–1851; Huxley, *Ann. N. H.* 1851, viii. 1; Gosse, *Mar. Zool.* i. 54; V. d. Hoeven, *Zool.* and *Suppl.* (Leuckart); Gegenbaur, *Vergl. An.* 205; Herapath, *Qu. M. J.* 1865, 175 (*pedicellariæ*); Frey, *Bedeck. wirbell. Th.*; Koren, *Arch. Scandinav.* i. 166, 449; Norman, *Ann. N. H.* 1865, xv. 98; Stewart, *Qu. M. J.* 1871; Nicholson, *Zool.* 1878, 181; Sladen, *Ann. N. H.* 1880, vi. 101 (*pedicellariæ*).

ECHINORHYN'CHUS, Müller.—A genus of Entozoa, order Acanthocephala.

Char. Body cylindrical or sacciform, somewhat elastic, transversely rugose, obtuse at both ends; furnished with a retractile proboscis, which is armed with from one to sixty regular transverse rows of recurved spines; sexes distinct; no mouth.

The species, which are very numerous, many microscopic, reside in the alimentary canal, most commonly of fishes and reptiles, less so in that of mammals, and still more rarely in that of birds.

E. anthuris (Pl. 21. fig. 35) is very common in newts; *E. proteus* in fish.

Bibl. Dujardin, *Helminth.* 483; Leuckart, *Paras.*

ECHI'NUS, Lam.—A genus of Echinodermata, of the family Echinidea.

The species are popularly known as 'sea-urchins,' or 'sea-eggs.'

The beautifully symmetrical structure of their spines, and their curious *pedicellariæ*, afford favourite objects to the admirers of nature's minute wonders. These organs are not confined to this single genus of the family.

See Echinodermata and Shell.

ECTINOSO'MA, Boeck.—A genus of Copepodous Entomostraca.

Four species; among sea-weeds. (Brady, *Copep., Ray Soc.* ii. 8.)

ECTOCARPA'CEÆ.—A family of Fucoideæ. Olive-coloured, articulated, filiform sea-weeds, with sporanges (producing ciliated zoospores) either external, attached to the jointed ramuli, or formed out of some of the interstitial cells. British genera:

* *Frond rigid; each articulation composed of numerous cells* (Sphacelarieæ).

Cladostephus. Ramuli whorled.

Sphacelaria. Ramuli distichous, pinnated.

** *Frond flaccid; each articulation composed of a single cell.*

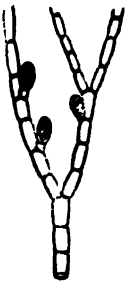
Ectocarpus. Frond branching; *ramuli* scattered.

Myriotrichia. Frond unbranched; *ramuli* whorled, tipped with pellucid fibres.

Bibl. See the genera.

ECTOCAR'PUS, Lyngb.—A genus of Ectocarpaceæ (Fucoid Algæ), consisting of olive or brown sea-weeds, with fronds composed of flaccid capillary filaments, growing between tide-marks or upon other Algæ. Filaments of very simple structure, the main axes or branches being composed of single rows of cells (fig. 183), as in *Cladophora.* The reproductive bodies at present known, ciliated zoospores, are formed in the cells of the branches, sometimes in the terminal cells, producing the siliquose or elliptical (fig. 183) sporanges, and sometimes in interstitial cells, beyond which the branch is prolonged into a fine filament. In *E. siliculosus* the extremities of the branches are converted into sporanges: the cell-contents first divide into a number of layers, while the part of the filament containing these swells up and acquires the pod-like form; the layers of contents are then resolved into lines of zoospores piled regularly one above another. The summit of the pod finally bursts, and the zoospores escape. The empty sporange exhibits fine transverse striæ, as if delicate septa existed between the layers of zoospores. In *E. litoralis*, Harv., the fertile cells are not terminal, but interstitial, and form beaded rows surmounted by a hair-like prolongation of the branch; the zoospores escape by a lateral pore. The germination of these zoospores has been observed by Thuret. Sixteen British species (Harvey), some of which are common, particularly the two above mentioned.

Fig. 183.



Ectocarpus verminosus.

Portion of a filament bearing lateral elliptical sporanges. Magn. 50 diams.

Bibl. Harvey, *Mar. Alg.* 58, pl. 9 *c*; *Phyc. Brit.* pls. 162, 197, &c.; *Eng. Bot.* pls. 2290, 2319, &c.; Thuret, *Ann. Sc. Nat.* 3 sér. xiv. 234, pl. 24. figs. 1–7; Agardh, *Ann. Sc. Nat.* 2 sér. vi. 197; Crouan, *ibid.* xii. p. 248, pl. 5.

ECTOPLEU'RA, Agassiz.—A genus of Hydroid Zoophytes, fam. Tubulariidæ.

E. Dumortierii. Isle of Man, Ostend.

Bibl. Hincks, *Brit. Zooph.* 124.

EEL (*Anguilla*).—It is popularly believed that the eel has no scales. They are, however, present, but immersed in the skin; and their structure is curious (Scales of Fish). The dried skin of the Eel, mounted in Canada balsam, exhibits well the scales, covered by the epidermis, and the beautiful layer of stellate pigment-cells.

Bibl. Yarrell, *Brit. Fishes*, ii.

EELS, in paste (Anguillula glutinis).

EELS, in vinegar (ANGUILLULA ACETI).

EGGS.—The minute ova of certain animals have always been favourite microscopic objects on account of their curious forms, the beautiful structure of their outer chitinous envelope, their varied colours, and the singular lids with which some of them are furnished. The most interesting are those of insects: among them we may mention the brown eggs of the puss-moth, *Cerura vinula* (Pl. 39. fig. 19); of the large and small cabbage-butterflies, *Pontia brassicæ* and *rapæ* (Pl. 39. fig. 21); of the small tortoiseshell butterfly, *Vanessa urticæ*; the angle-shades moth, *Noctua* or *Phlogophora meticulosa*; the common meadow brown butterfly, *Hipparchia Janira*; the brimstone moth, *Rumia cratægata*; the water-scorpion, *Nepa ranatra*; the common cow-dung-fly, *Scatophaga stercoraria*, which are very common on cow-dung; the bug, *Cimex lectularius* (Pl. 39. fig. 20), *Hydrometra stagnorum*, &c.

Their surfaces exhibit markings of the most varied forms—spines, tubercles, pits or processes, sometimes of considerable length (Pl. 21. figs. 22, 23), often arranged with great symmetry, and frequently closely resembling the cellular structure of plants in appearance. Sometimes very delicate angular spaces are mapped out upon them, the intervals being most minutely dotted, as in the eggs of the common blow-fly, *Musca vomitoria* (Pl. 34. fig. 35).

It is a general fact, exemplified in both the animal and vegetable kingdom, that unicellular, or the corresponding stages or phases of the higher organisms, exhibit markings of some kind upon their external membrane or wall, as is seen in the cells of the Desmidiaceæ, the Diatomaceæ, the eggs of animals, the spores and pollen-grains, and the seeds of plants.

At certain seasons of the year, the eggs of some aquatic animals are provided with a very thick horny coat, as in the Entomostraca, *Hydra*, &c. These have been called winter ova, from the notion that here was a defence against a low temperature; they correspond to the resting-spores or resting-stages of the Infusoria and Algæ, some of which were formerly included in the animal kingdom. The formation of this coat can scarcely have any relation to temperature, either from its structure or from its requirement in an organism which has no heat to retain. Its presence would be perfectly intelligible, however, as a means of protection from evaporation when the pools become dry; and for this purpose its structure is well adapted. It might also afford a protection against the attacks of predatory animals, many of which could easily devour an ovarian ovum, while they could not break through the horny cases of the winter ova; and these winter ova are only formed when the ova are not to be hatched soon after extrusion from the parent. The ova of those animals which are never hatched immediately after leaving the parent, have always a coat corresponding to that of the winter ova.

The structure and development of eggs are considered under OVUM; see also SHELL.

BIBL. See OVUM.

EHRENBERGI'NA, Reuss.—A Cassiduline Foraminifer with the later portion of the shell uncoiled.

BIBL. Carpenter, *Introd. Foram.* 198.

ELACHIS'TEA, Fries. — A genus of Myrionemaceæ (Fucoid Algæ). Minute epiphytic sea-weeds, consisting of a dense tuft of simple, articulated, olivaceous filaments, from a common tubercular base composed of a closely combined mass of dichotomously branched filaments, growing upon larger Fucoids, such as *Fucus*, *Himanthalia*, *Cystoseira*, &c. The fructification is borne in two forms—unilocular (*spores*, Harvey) and multilocular *sporanges* (*paranemata*, Harvey). The unilocular are formed of metamorphosed terminal cells at the ends of the dichotomous filaments; they are long ovoid sacs, the contents of which are ultimately converted into a vast number of zoospores. The multilocular sporanges arise exactly in the same place and way, but take the form of long, slender, articulated filaments, in the joints of which similar but smaller zoospores are developed. Both forms of fructification nestle on the surface of the tubercle of the frond, at the base of the long simple filaments. The zoospores of both kinds of fruit germinate; and these occur together in some cases (*E. attenuata*), in others at different seasons of the year. Harvey describes seven British species; the tufts of some are half an inch long, of others less than a line.

BIBL. Harvey, *Mar. Alg.* 49, pl. 10 F; *Phyc. Brit.* pls. 240, 260, 261, &c.; Dillw. *Conferv.* pl. 66 &c.; Thuret, *Ann. Sc. Nat.* 3 sér. xiv. p. 236, pl. 25. figs. 1–4.

ELÆAGNA'CEÆ.—A family of Dicotyledons, the leaves of which are usually covered with a kind of scurf formed of very

elegant microscopic scales. See HAIRS, and HIPPOPHAË.

ELAPHOMY'CES, Nees.—A genus of Tuberacei (Ascomycetous Fungi) consisting of subterraneous truffle-like plants, with a warty or hairy rind, not bursting spontaneously, but divided into little chambers internally by intersecting plates of sporiferous tissue. The spores are formed in sacs (*asci*) (fig. 185), from four to eight in each, arising from branched anastomosing filaments (*capillitium*). Three species are found in this country:—*E. anthracinus*, Vitt., in clayey ground; *E. granulatus*, growing in heathy ground; and *E. muricatus*, Fr. (*E. variegatus*, Vitt., Tulasne), attached to the rootlets of beeches. L. and C. Tulasne have carefully analyzed this genus.

BIBL. Berk. *Br. Fl.* ii. pt. 2. 306; *Ann. N. H.* vi. 430, pl. 11. fig. 10; L. and C. Tulasne, *Ann. Sc. Nat.* 2 sér. xvi. p. 5, pls. 1-4; *Hypog. Fungi*, 1850; Vittadini, *Monog. Tuber. App.* 66, &c., pls. 3 & 4; Berk. & Br. *Ann. N. H.* xviii. 81.

Fig. 184.

Fig. 185.

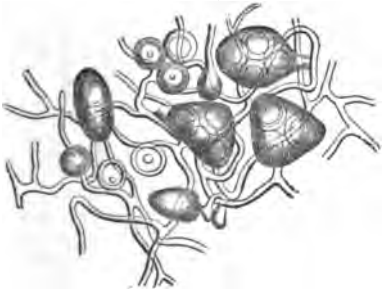


Fig. 184. Elaphomyces hirtus. Section, nat. size.
Fig. 185. E. variegatus. Filaments of capillitium, with asci containing spores, and also loose spores which have escaped. Magnified 300 diameters.

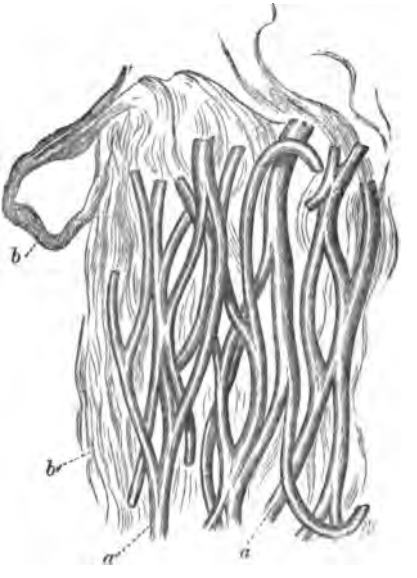
ELASTIC LIGAMENTS.—These are yellowish strong bands, consisting of elastic or yellow fibrous tissue, with a small quantity of connective tissue. They are met with connecting the arches of the vertebræ (ligamenta subflava), in the stylo-hyoid and internal lateral ligaments of the jaw, and the

Fig. 186.

Transverse section of the ligamentum nuchæ of an ox, after treatment with solution of caustic soda: *a*, connective tissue, appearing transparent; *b*, section of elastic fibres. Magnified 350 diameters.

ligamentum nuchæ, or 'paxy-waxy,' of animals. They contain but few vessels, and no nerves. The elastic fibres (fig. 187) are from 1-7500 to 1-3500″ in breadth, slightly flattened (fig. 186), mixed with still finer and some coarser elastic fibres, forming a dense network, taking a general direction parallel to the long axis of the spine. Between these fibres are loose undulating

Fig. 187.



Elastic fibres: *a*, from a human ligamentum subflavum, with intervening connective tissue, *b*. Magnified 450 diameters.

bundles of connective tissue, running parallel to the elastic fibres.

BIBL. Kölliker, *Mik. An.* ii. 306, and

Gewebel. d. Mensch.; Rollett, *Stricker's Gewebe*. i. 59.

ELASTIC TISSUE of animals, or yellow fibrous tissue, occurs in the ligamenta subflava of the vertebræ, in the thyro-hyoid and cricoid membranes, the vocal chords, the trachea, forming the longitudinal elastic bands of that tube and its branches, in the internal lateral ligament of the jaw, the stylo-hyoid ligament, the transversalis fascia of the abdomen, the blood-vessels, and almost everywhere mixed with the fibres of connective tissue.

It differs from white fibrous tissue in its elasticity and its yellow colour. But some physiologists regard it as a variety of this.

Its elementary form is that of round or flattened fibres, varying in size from an almost immeasurable tenuity to that of 1-2200″ or even more; the finer ones have been termed nuclear fibres by the Germans; they are either isolated, arranged in bundles, or branching and anastomosing (fig. 189), sometimes undulating or spiral, at others nearly straight. When broken, they curl up, the ends appearing abrupt or truncated. They are highly refractive, their edges appearing dark, well-defined, and mostly smooth, but sometimes toothed or serrated. Sometimes they exhibit transverse cracks upon the surface.

Fig. 188. Fig. 189.

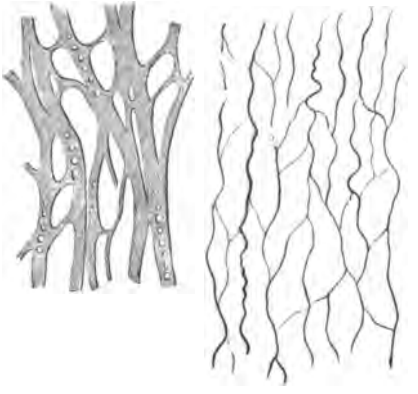


Fig. 188. Network of elastic tissue, from the middle coat of the pulmonary artery of the horse. Magnified 350 diameters.

Fig. 189. Network of fine elastic fibres from the peritoneum of a child. Magnified 350 diameters.

They are easily distinguishable from fibres of connective tissue by the use of acetic acid, which has little or no effect upon them; and this is also the case with solution of potash. Sometimes by their anastomoses they form fibrous networks (fig. 189), or plates perforated irregularly by holes — fenestrated membranes (fig. 188). The fibres are also themselves sometimes transversely perforated by irregular rounded apertures.

Chemically, elastic tissue consists of elastine. It is coloured red by Millon's test, but not by that of Pettenkofer, and does not yield gelatine by boiling.

Elastic tissue is probably developed from cells. In all parts of embryos where elastic tissue occurs, peculiar fusiform or stellate cells (fig. 190 *a*) with acute ends or processes are met with, by the fusion of which (fig. 190 *b* & 191) long fibres or networks are formed, in which the spots corresponding to the cells at first form dilatations with elongated nuclei. The fibres frequently remain in this condition, forming a modification of the so-called nuclear fibres; or

Fig. 190. Fig. 191.

Fig. 190. Formative cells of elastic tissue, from the tendo Achillis: *a*, of a four months' embryo; *b*, of a seven months' fœtus; some of the cells are free, with one or two processes, others fused in twos and threes. Magnified 350 diameters.

Fig. 191. Stellate formative cells of nuclear fibres, from the tendo Achillis of a newly born infant. Magnified 350 diameters.

all traces of the original composition vanish, uniform fibres or networks alone remaining. There is, however, great difference of opinion among physiologists as to the development of elastic tissue, some regarding it as arising from fibrillation of the intercellular substance.

Elastic tissue occurs in the same situations in all classes of the Vertebrata as in man—also in some special localities, as in the ligaments of the claws of the cat, the folds of the wing-membrane, and the pulmonary sacs of birds. In the Invertebrata, this tissue appears to occur but rarely; and it is uncertain whether the elastic ligaments existing in them, *e.g.* those of the mollusca, agree anatomically and chemically with the elastic tissue of the higher animals or not.

BIBL. Kölliker, *Gewebel.*; Reichert, *Müll. Archiv*, 1856, Hft. vi. 55; Leydig, *Hist.* 27; Frey, *Histol.* 1876 (very complete literature), 246; Beale, *Simple Tissues*; Rollett, *Stricker's Handb.* i. 59.

ELASTINE.—The proximate chemical principle of which elastic tissue consists.

EL'ATERS.—This name is applied to two forms of structure occurring in the higher Cryptogamous Plants. The elliptical spores of the Equisetaceæ are furnished with what are called elaters, viz. four elastic filaments, attached about the middle of one side, which are coiled once or twice round the spore before it is discharged from the capsule, in the position where they were originally developed; but when the spore is discharged, they uncoil with elasticity, causing the spore to be jerked away. They appear to be produced by the outer coat of the spore splitting in spiral fissures, and separating in ribands from the inner coat. See EQUISETACEÆ.

The elaters of the Liverworts or Hepaticæ are of different nature; they consist of more or less elongated delicate membranous tubes, which are closed cells, inside which one or more elastic spiral fibres are coiled up. They occur mixed with the spores in the capsules of the Jungermanniеæ, sometimes attached to the valves; they here mostly present the appearance of cylindrical cellulose tubes, closed at the ends, with a flat spiral band coiled in an open spiral, adherent to the cell-membrane forming the wall (Pl. 40. fig. 38). The elaters found among the spores of *Marchantia polymorpha* (Pl. 40. figs. 36, 37) are very long, and contain a double coil, the ends of the two fibres coalescing into a loop at each extremity (Pl. 40. fig. 37 *b*); so that the entire fibre may be compared to a piece of string with its ends united, and laid out so as to represent two cords, side by side, which are then twisted spirally round one another. In TARGIONIA the tubes are sometimes branched. The development of the spiral fibres is similar to that of the spiral fibres of vessels. See HEPATICÆ.

Structures apparently analogous to these elaters of the Hepaticæ occur in some of the Myxogastrous Fungi, as in TRICHIA (Pl. 40. fig. 39*a*); while in other genera of this family filamentous bodies occur, either plain or obscurely marked. In *Batarrea* also, one of the Puff-balls, a kind of elater exists accompanying the spores (see TRICHOGASTRES). It has been stated by Schleiden and Schacht that the elaters of these Fungi are solid filaments with spiral ridges upon them, or flat solid ribands twisted on their longitudinal axis. This statement is at variance with our observations, and is not borne out by the drawings given by these authors themselves. Currey, while also contesting Schleiden's view, states that the spiral line is a ridge outside a tube,—a condition of things unlike any thing else we are acquainted with in vegetables.

The elaters of *Trichia* require a very high power for their elucidation, an eighth or twelfth, with a high eyepiece, and a good light; they may then be seen to consist of tubes with spiral fibrous secondary deposits upon the *inside* of their walls (Pl. 40. fig. 40). See SPIRAL STRUCTURES.

BIBL. See EQUISETACEÆ, MARCHANTIA, TRICHIA, and SPIRAL STRUCTURES.

ELDER.—*Sambucus niger*, the common Elder tree (Caprifoliaceæ, Dicotyledons), is remarkable for the great development of its pith; sections of this furnish very accessible and convenient illustrations of vegetable parenchyma.

ELLIPSOIDI'NA, Seguenza.—An egg-shaped hyaline Foraminifer, probably Cryptostegian. The adult has three concentric chambers, one within another, touching at their bases and kept apart at the apices by an internal column. An irregular septal orifice surrounds the column as it passes through the chamber-wall. *E. ellipsoides* and its varieties only are known. From the Mid-Tertiary beds of Sicily.

BIBL. Brady, *Ann. N. H.* 1868, i. p. 333.

ELYTRA.—The horny anterior pair of wings of the Coleoptera; sometimes called wing-covers or wing-cases, because they

cover and protect the subjacent pair of membranous wings of these insects when not in use.

The elytra may be regarded as consisting of an elongated, depressed fold of the integument, comparable to the web between the fingers, or that of the bat's wing. Four structures are distinguishable in them:—1, an outer, firmly adherent, epidermic layer, composed of minute cells, frequently undistinguishable, or at least only to be detected in parts; this layer is continued around the margins of the elytra, so as to cover their inferior surface also, forming, 2, the inner epidermic layer, in which the cells are stated to be less distinct, more rounded, and more closely placed than those in the upper layer, hence presenting a more distinctly angular form; this layer is easily detached from the elytra, and its surface next the body of the insect is frequently furnished with a number of very minute hairs, or spiniform papillæ directed backwards (Pl. 34. fig. 2). Beneath the outer epidermic layer is 3, a layer of dark resinous pigment; whether contained in cells or not has not been determined. 4, an intermediate portion, composing the principal thickness of the elytrum, representing the two fused strata of the cutis, and consisting of a number of fibres, running in different directions, variously interlacing, anastomosing, and crossing, so as to form numerous plates or secondary layers, many of which present a fenestrated appearance; as many as sixteen of these plates have been separated.

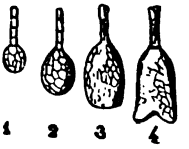
The veins or nerves of the elytra either traverse the intermediate thick layer of the elytra, or run between its under surface and the inner epidermic layer, to which they sometimes remain adherent. See INSECTS.

The structure of the elytra can only be made out by macerating them for a long time in solution of caustic potash, or water.

BIBL. Schmidt, *Taylor's Sc. Memoirs*, v. 16; Meyer, *Müller's Archiv*, 1842, 12; Nicolet, *Ann. Sc. Nat.* 3 sér. vii.; and the BIBL. OF INSECTS.

EMBRYO, OF PLANTS.—This is the name applied to the rudimentary plant contained in all true *seeds*. Seeds containing embryos are borne exclusively by Flowering Plants; and while the external conditions under which the seeds are produced afford the character for the first subdivision of this province of the Vegetable Kingdom (ANGIOSPERMS and GYMNOSPERMS), the structure of the embryo is taken as the most striking character in further subdividing the Angiospermous Flowering Plants into their two great natural groups, viz. Monocotyledons and Dicotyledons, in which, respectively, the embryo bears one or two *cotyledons* or seed-leaves. Cases occur both among the Dicotyledons and the Monocotyledons where the typical structure is departed from. Thus in Orobanchaceæ (Dicotyledons) the embryo is a mere globular mass of cellular tissue, the result of an arrest of development, the cotyledons and radicle never becoming distinct; the same is the case in the Orchidaceæ among the Monocotyledons, the embryo not advancing beyond the state of a globular mass of parenchyma. The relation of such embryos to the perfect forms is well illustrated by comparing the stages of growth of embryos which acquire fully-developed cotyledons and radicle (fig. 192). In *Cuscuta*, a leafless plant, the

Fig. 192.



A young Dicotyledonous embryo in successive stages of development. All exhibit the suspensor; and 4 has the cotyledons appearing, separated by a notch. Magnified 50 diameters.

embryo has no distinct cotyledons. Other anomalies of another kind also occur. Some Monocotyledons, such as those of Grasses, have the rudiment of a second cotyledon; but this is *above* and *not opposite* the other larger one. In Dicotyledons the cotyledons are not unfrequently unequal, and sometimes soldered together. In the Coniferæ the embryos appear to have four, eight, or more cotyledons in different cases; but it is stated that there exist only two, divided or compound, cotyledons (see SEEDS).

Occasionally more than one embryo occurs in a seed (see POLYEMBRYONY); and in the Coniferæ a number of embryos are at first produced, of which one only becomes perfectly developed (see GYMNOSPERMIA).

The embryo sometimes constitutes the whole mass of the seed, merely enclosed in the coats; in other cases it is embedded in a mass of albumem. In the former case the tissue of the cotyledons often assumes characters similar to those of the ALBUMEN, serving as a receptacle for stored nutriment for the germinating plant, in the form of

fleshy secondary deposits, starch, oil, &c. The position of the embryo in the albumen, or the modes in which the embryo is folded up within the seed-coats, are of great importance in systematic botany, for the characterization of families. Particulars regarding these points, and the manner of examining them, are given under the head of SEED. The development of embryos is described under OVULE. See also ORCHIDACEÆ, OROBANCHACEÆ, CUSCUTA.

BIBL. Henfrey-Masters, *Bot.* 634; Brongniart, *Ann. Sc. Nat.* xii. 14, &c.; Jussieu, *ibid.* 2 sér. xi. 341; St.-Hilaire, *Ann. Sc. Nat.* 2 sér. v. 193; Duchartre, *Ann. Sc. Nat.* 3 sér. x. 207; Hofmeister, *Abh. sächs. Ges. Wiss.* vi. & vii.; Sachs, *Bot.* 553; and the BIBL. of the articles OVULE, SEED, &c., above referred to.

EMBRYO-SAC, OF PLANTS.—A cell which becomes enlarged into a sac in the substance of the upper part of the nucleus of the ovule or rudiment of the seed. In the cavity of this are developed the germinal vesicles (Pl. 47. figs. 3, 4, 5), one of which (occasionally more), after fertilization, gives origin to the EMBRYO. The most common condition of the embryo-sac is that of a large cavity excavated in the nucleus, bounded by its own cell-membrane, and containing abundant protoplasm, and subsequently germinal vesicles and endosperm-cells (see OVULE). Not unfrequently, however, it becomes developed into diverse saccate processes, either pushing their way through the substance of the nucleus in variable directions (*Scrophulariaceæ* &c.), or emerging from the micropyle, coming to meet the pollen-tube (*Viscum*), or even so much developed externally that the embryo is formed and perfected altogether outside the nucleus (*Santalum*). These and other conditions are further described under OVULE. When the germinal vesicle is fertilized, and is undergoing development to produce the embryo, the embryo-sac often becomes completely filled with endosperm-cells, at first free, but afterwards adhering together through their crowded condition. These may persist and form an *endosperm* to the seed, as in *Nuphar*, where there is an additional *episperm* formed outside the embryo-sac from the substance of the nucleus. Albuminous seeds generally have either an episperm or an endosperm alone. In exalbuminous seeds the endosperm originally existing inside the embryo-sac becomes absorbed through the pressure of the growing embryo, the embryo gradually filling up the cavity, and by further expansion obliterating the embryo-sac and nucleus. See ALBUMEN, of Seeds.

In the Coniferæ the embryo-sac, originally formed by the excessive expansion of one of the cells near the apex of the nucleus, becomes subsequently filled up by cellular tissue, in the upper part of which become developed the bodies called *corpuscula*, each of which possesses a kind of secondary embryo-sac of its own, in which the germinal vesicles are developed (see GYMNOSPERMIA).

The term embryo-sac might also be applied to the large cell at the base of the archegonia of the FERNS, LYCOPODIACEÆ, MOSSES.

BIBL. See OVULE and GYMNOSPERMIA.

EMPUSI'NA, Cohn. See SPORENDONEMA.

EMYD'IUM, Doyère (*Echiniscus*, Schultze).—A genus of Arachnida, order Colopoda, family Tardigrada.

Char. Head furnished with appendages; mouth conical, without appendages or terminal sucker; epidermis semisolid, presenting, especially on the upper surface of the body, an evident annular division.

E. testudo (Pl. 50. fig. 7). Reddish-brown; body ovoid, opaque; snout conical, presenting traces of division into three rings; head indistinctly divided into three segments, the first and third presenting short setiform filaments supported upon very short tubercles, the second with a palpiform, blunt and flattened appendage; pharyngeal tube very slender; styles straight; bulb without an internal jointed framework; eye-spots small, oval, simple, most visible at the under aspect of the body; trunk divided into four simple rings, with spines and long filaments; legs three-jointed, each with large and strong claws, the posterior pair with a kind of spur also at the back part of the lower margin of the second joint; movement excessively slow; length, from the end of the extended snout to the posterior border of the fourth ring, 1·80″. Found on the moss covering tiled roofs; common.

E. spinulosum, *E. granulatum* } rare.

BIBL. Doyère, *Ann. Sc. Nat.* xiv. p. 279.

ENALLOSTE'GIA. — One of D'Orbigny's orders of Foraminifera, having the chambers alternate in two or three rows, not spiral; such as *Polymorphina* and *Textularia*.

ENCALYP'TA, Schreb.—A genus of Ca-

lymperaceæ (Pottioid Mosses), containing several British species.

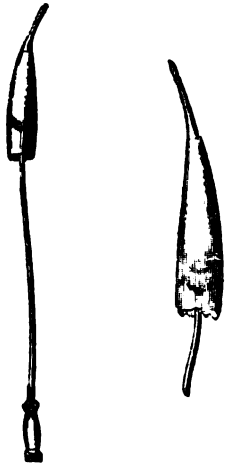
Bibl. Wilson, *Bryol. Br.* 140; Berk. *Handb.* 246.

Fig. 193. Fig. 194.

Encalypta commutata.

Fig. 193. A single plant. Magnified 5 diameters.
Fig. 194. The mouth of the capsule, showing the rudimentary peristome. Magnified 50 diameters.

Fig. 195. Fig. 196.



Encalypta commutata.

Fig. 195. Capsule on stalk, with vaginule at base, and calyptra above. 10 diameters.
Fig. 196. Capsule enclosed in its calyptra. 20 diameters.

ENCEPH'ALOID, or Encephaloid Cancer.—That form of cancer in which the morbid substance has the appearance and consistence of the medullary part of the brain; hence sometimes called medullary cancer.

See Tumours, Cancerous.

ENCHE'LIA, Ehr.—A family of Infusoria.

Char. No carapace, ciliated, oral and anal orifices at opposite ends of the body.

Ehrenberg distinguishes the genera thus:

- Mouth toothless.
  - Surface with very fine cilia
    - Mouth directly truncate, no lip
      - oral cilia
        - Body single — *Enchelys.*
        - double — *Disoma.*
    - Mouth obliquely truncate, with lip
      - no neck — *Trichoda.*
      - a neck — *Lacrymaria.*
  - Surface with evident cilia
    - Mouth obliquely truncate, with a lip — *Leucophrys.*
    - Mouth directly truncate, without a lip — *Holophrya.*
- Mouth with teeth — *Prorodon.*

Dujardin's family Enchelia bears no relation to that of Ehrenberg. He defines it as consisting of animals partly or entirely covered with diffused cilia, no mouth; and subdivides it thus:—

- Not ciliated all over
  - Cilia at one end — *Acomia.*
  - Cilia in a longitudinal furrow — *Gastrochæta.*
- Ciliated all over
  - Cilia all alike — *Enchelys.*
  - Both cilia and trailing retractile filaments — *Algoscum.*
  - One long straight cilium posteriorly — *Uronema.*

Kent includes in the family: *Enchelys, Metacystis, Perispira, Anophrys, Colpoda,* and *Tillina.*

ENCHEL'YODON, Cl. & Lach.—A genus of Holotrichous Infusoria.

Char. Free, ovate, narrowed in front; mouth terminal, with a longitudinally plicate œsophagus.

Two species; freshwater and marine. (Cl. & Lachm. *Inf.* 316; Kent, *Inf.* 503.)

EN'CHELYS, Hill.—A genus of Infusoria, family Enchelia, Ehr. (Trachelina, Cl. & Lach.).

Char. Body single, ovate, free, very finely ciliated on the surface; mouth without teeth, ciliated, directly truncated. Bogwater and infusions.

E. pupa, E. (Pl. 30. fig. 48). Body ovate, turgid, attenuated in front, containing yellowish-green granules; length 1-144″.

E. farcimen. Smaller than the last, 1-1432″; internally whitish.

E. arcuata, Cl.

Two other species.

Dujardin's genus *Enchelys* belongs to *Cyclidium.*

BIBL. Ehrenb. *Inf.* 298; Dujardin, *Inf.* 385; Stein, *Inf.* 137; Clap. & Lachm, *Inf.* 309; Kent, *Inf.* 509.

ENCHONDRO'MA. See TUMOURS.

ENCYONE'MA, Kütz.—A genus of Diatomaceæ.

Char. Frustules resembling those of *Cymbella,* arranged mostly in longitudinal series, in gelatinous tubes; freshwater.

Valves very variable in form, even in the same tube, showing how little dependence is to be placed upon this feature as a character.

E. prostratum (Pl. 19. fig. 10). Filaments nearly simple; length of frustules 1-1560 to 1-600″.

E. cæspitosum. Filaments divided at the ends, tufted.

2 other European species, and 2 foreign.

BIBL. Kützing, *Bacill.* 82, and *Sp. Alg.* 61; Ralfs, *Ann. N. H.* 1845, xvi. 111; Berkeley, *ib.* 1841, vii. 449; Smith, *Brit. Diat.* ii. 68; Rabenhorst, *Fl. Alg.* i. 85.

ENDIC'TYA, Ehr. = COSCINODISCUS in part. *E. oceanica* = *C. oc.* K.

ENDOCAR'PON, Hedw.—A genus of Lichens, tribe Pyrenocarpei, with pale perithecia immersed in a peltate or squamiform coriaceous thallus; growing on rocks, in streams, and on the ground.

4 British species: *E. miniatum, fluviatile, rufescens,* and *hepaticum.*

BIBL. Leighton, *Angioc. Lich., Ray Soc.* 1851, 10, pl. 1, and *Lich. Fl.* 441; Tulasne, *Ann. Sc. Nat.* 3 sér. xvii. 90, 213, pls. 10 & 12; Hook. *Br. Fl.* ii. pt. 1. 159; Schærer, *Enum.* 230, pl. 9. fig. 2.

EN'DOCHROME.—This term is applied to the cell-contents, or the miscellaneous collection of substances and structures enclosed in the cavity of a cell. In an Alga, therefore, like *Zygnema,* it comprehends the *primordial utricle* or layer of protoplasm lining the cell-wall, together with the chlorophyll-globules or vesicles, starch-granules, nucleus, and liquid and granular protoplasm contained in the cavity of the cell. It is perhaps a useful word in roughly describing a species, but it is too indefinite to be admissible in any accurate description of cellular structures; moreover, as it is not a definite collection of substances, nor always coloured, the use of the term *cell-contents* is to be preferred in all cases, as not indicating any positive characters.

ENDOCOCCUS, Nyl.—A genus of Lichens containing the parasitic species of VERRUCARIA.

BIBL. Leighton, *Lich. Fl.* 492.

ENDODRO'MIA, Berk. A curious genus of Mucorini (Phycomycetous Fungi), distinguished by a very delicate vesicle perforated by the stem, filled with delicate branched radiating threads and globose spores, each of which has a nucleus endowed with active motion. *E. vitrea,* the only species, is found on sticks in damp woods.

BIBL. *Hook. Jn.* iii. 79; Berk. *Outl.* 408.

EN'DOGEN. See MONOCOTYLEDONS.

ENDO'GONE, Lk.—A genus of Mucorini (Phycomycetous Fungi), consisting of one or two Hypogæous species, the flocci being collected into a globose spongy mass, and terminated by globose vesicles, solitary or in fascicles. Two species, *E. pisiformis,* Lk., and *E. lactiflua,* B. & Br., have been found in this country.

BIBL. *Ann. N. H.* 1846, xviii. 81; Berk. *Outl.* 409.

ENDOS'MOSE, Osmosis or Dialysis.—This name is applied to a phenomenon which takes place when two different liquids, having an attraction for each other, are separated merely by a porous diaphragm or an organic membrane. A diffusion takes place, by which the liquids become mixed, but one of them flows more rapidly into the other. Thus when alcohol and water are so placed, the water flows into the alcohol (*endosmose*) much more strongly than the alcohol into the water (*exosmose*). The same attraction occurs when syrup or a solution of gum is substituted for the spirit, and also alkaline salts. When acids or acid salts are placed in the same relation to water, the current is strongest towards the water. Acids and alkaline solutions exert the strongest action, neutral substances the weakest. Dilute solutions act more efficiently (proportionally) than strong ones. The importance of the effects of endosmose on microscopic objects viewed in liquids, has been mentioned in the INTROD. (p. xli). Delicate structures are often advantageously wetted with dilute solution of sugar, common salt, or glycerine, to prevent the changes from endosmosis which result from the use of pure water.

Graham divided organic matters into two

classes: the crystalloid, or those which will pass through a porous membrane, as soluble salts; the colloid, or those which will not, as albuminous matters. This subject is of special interest in regard to the nutrition of animal and vegetable cells. For if their walls are impervious to the so-called colloid substances, a cell may be bathed with them, and yet have to produce its own sarcodic matter or protoplasm.

Bibl. Fischer, *Pogg. Ann.* xi. 126; Dutrochet, *Cycl. Anat. and Phys.* ii. 98; *Works on Physics*, as Buff, *Experim.-Physik*; Pouillet, *Elém. d. Physique*; Peschel, *Physics*, &c.; Graham, *Proc. Roy. Soc.* vii. 83; Watts, *Dict.* (Dialysis); L'Hermite, *Ann. Sc. Nat.* 4 sér. ii. 73; Nägeli, *Phys. Unters.*; Hoppe-Seyler, *Chim. Phys.* 11; Rodwell, *Dict. Sc.* 162.

EN'DOSPERM. See Albumen, of Plants.

EN'DOSPORE.—The name applied by some authors to the inner coat of spores. See Spore.

ENERTHENE'MA, Bowm.—A genus of Myxomycetes interesting from the fact that the spores have been observed *in situ*; they are produced, five or six together, in globular sacs (*asci*) attached to the free apices of the filaments of the capillitium, which arise from a disk at the top of the percurrent stem (Pl. 27. fig. 9). *E. elegans* was found by Bowman near Wrexham; and it has since been found in South Carolina, and in Scotland.

In the clustered spores it resembles *Badhamia* and some species of *Reticularia* figured by Corda.

Bibl. Bowman, *Linn. Tr.* xvi. 151, pl. 16; Berk. and Broome, *Ann. N. H.* 1850, v. 366, pl. 11. fig. 7.

ENHYDROSO'MA, Boeck.—A genus of Copepodous Entomostraca.

E. curvatum, in dredgings. (Brady, *Copepoda, Ray Soc.* ii. 97.)

ENOP'LIDÆ, Duj.—A tribe of Nematoid Entozoa, distinguished by an oral or pharyngeal armature, consisting either of styles, hooks, or rods (bacilli). The members are microscopic, and live in fresh or sea-water, whence they sometimes find their way into the alimentary canal of higher animals. Genera:

Dorylai'mus. Filiform, narrowed at the ends; mouth tubular, retractile, armed with a single very long horny style; male with two equal, short, falciform spicules; female with the vulva in the middle of the body, the uterus divided into two opposite branches; ova large, oblong.

D. stagnalis. In the intestines of the carp and *Gasterosteus. D. marinus*; marine.

Passalu'rus. Fusiform, elongate, narrowed behind, with a subulate tail, or suddenly narrowed; head obtuse; mouth with three oblong pieces (jaws), united by a resisting folded membrane; œsophagus clavate, succeeded by a broader stomach; skin transversely striate; male with a single spicule; female with the vulva near the stomach; uterus and ovaries simple; eggs large, oblong.

P. ambiguus. Large intestine of the rabbit and hare.

Enop'lus. Filiform, narrowed at the ends, most behind; head angular or truncate, with a few opposite setæ; mouth with three uncinate jaws; œsophagus almost cylindrical, cavity triquetrous; tail ending in a kind of sucker; one or more red eye-like spots on the œsophagus; skin smooth; male with a supplementary orifice (anus or sucker) in front of the genital orifice, and with two equal curved spicules; vulva near the middle of the body; uterus divided into two opposite branches; eggs elliptical. Marine and freshwater.

Oncholai'mus. Filiform, more or less narrowed at the ends; head obtuse; buccal cavity large, with two or three curved or hooked jaws, placed lengthwise, at least one with a prominent tooth; œsophagus elongate, nearly cylindrical; no stomach; tail apparently terminated by a sucker; skin smooth. Male—tail suddenly narrowed, short; spicules two, equal. Female—vulva near, or slightly behind the middle; uterus two-branched; eggs elliptic, large. Marine and freshwater; length 1-10″.

Anguil'lula (Rhabditis). Pharynx with two or three longitudinal bacilli.

Atrac'tis. Mouth with two or three jaws; spicula two, unequal.

Doubtful genera:

Amblyu'ra, Ehr. Filiform, mouth truncate, with cirrhi; tail subulate, slightly expanded at the end, where there is a suctorial papilla; spicule single, retractile, without a sheath. Probably species of *Oncholaimus* or *Enoplus.*

A. serpentulus= Vibrio s., Müller. Found in an old vegetable infusion.

A. gordius= Vibrio g., Müll. In marine infusions.

Phanogle'ne. Filiform, pointed behind; mouth truncate, bilobed, with cirrhi, and

with red eye-spots behind the head; spicule single.

P. micans. Eye-spots contiguous; cirrhi two. In the intestine of the larva of a neuropterous insect.

P. barbiger. Cirrhi four; red spots separate. In stagnant water.

Enchilid'ium. Filiform, a single red eye-spot, as broad as the body, situate at some distance from the head. Marine.

See ANGUILLULIDÆ.

BIBL. Dujardin, *Helminth.* 236; Nordmann, Lamarck's *Anim. sans Vert.* iii. 564; Bastian, *Linn. Tr.* xxv. 73.

ENTEROBRY'US, Leidy.—A supposed genus of Kützing's Leptomiteæ, probably the mycelium of some fungus, found in the intestines of insects.

ECCRI'NA, Leidy, is another of these forms.

BIBL. Leidy, *Proc. N. H. Soc. Philadel.* 1849, 225, *Ann. N. H.* 1850, v. 72; Robin, *Végét. Paras.* 1853, 395, pl. 4. figs. 5, 6.

ENTERO'COLA, Van Ben.—A genus of Copepodous Entomostraca.

E. eruca, is found adhering to the intestine of *Ascidia intestinalis.* (Brady, *Copepoda, Ray Soc.* i. 147.)

ENTEROMOR'PHA, Link.—A genus of Ulvaceæ (Confervoid Algæ), consisting of freshwater and marine plants, with branched, tubular, green fronds, the walls of the tubes being composed of a single flat layer of polygonal cells. Reproduction by ciliated zoospores, formed in considerable numbers from the transformed contents of the cells (Pl. 9. fig. 4). In this genus, Thuret states that two forms of zoospores occur,—one large and four-ciliated; the other, in fronds with a yellower tint, smaller and with two cilia; both kinds germinate. The zoospores escape from the cells by a pore on the outer surface (Pl. 9. fig. 4 *a*) near the centre of the cells; and the latter persist for some time in an empty condition. The marine forms, of which nine species are described by Harvey, are mostly from 1-2‴ to several lines in diameter, but many inches long. *E. Grevillei,* Thuret (*Ulva Lactuca,* Grev., Harv.), however, is thicker and saccate, finally bursting. *E. intestinalis,* which grows both in the sea and in brackish- and freshwater ditches, often attains a length of 2 feet and more, and varies in thickness from 1‴ to 2-3″.

BIBL. Harvey, *Mar. Alg.* 213, pl. 25 D, *Phyc. Brit.* pls. 63, 262, 282; Greville, *Alg. Brit.* 179, *Sc. Crypt. Fl.* t. 313, *Eng. Bot.* 2137 & 2328; Thuret, *Ann. Sc. Nat.* 3 sér. xiv. 224, pl. 20. figs. 8-12; *Mém. de Cherbourg,* ii.; Rabenhorst, *Fl. Alg.* iii. 312.

ENTERO'PLEA, Ehr.—A genus of Rotatoria, of the family Hydatinæa.

Char. Eye-spots none; teeth absent; foot forked.

E. hydatina (Pl. 43. fig. 27). Body conical, hyaline; foot small; aquatic; length 1-120″.

Probably the male of *Hydatina.*

BIBL. Ehrenb. *Infus.* p. 411.

ENTODIN'IUM, Stein.—A genus of Peritrichous Infusoria.

Char. Free, ovate, flattened; surface smooth, indurated; often with one or more terminal spines. Three species; in the rumen and reticulum of Ruminants.

BIBL. Stein, *Inf.* ii. 168; Kent, *Inf.* 653.

ENTOGO'NIA, Grev.—A genus of fossil Diatomaceæ.

Char. Frustules in side view triangular, containing a central triangular figure, having a broad border divided by transverse costæ into punctate or cellulate compartments: =species of *Triceratium.*

11 species. Barbadoes.

BIBL. Greville, *Qu. Mic. Jn.* 1863, 235 (figs.).

EN'TOMIS, Jones.—An extinct bivalved Entomostracan, known by its oval, transversely sulcate, and sometimes concentrically wrinkled valves. The sulcus is nuchal and much stronger than in some of the Cypridiniform allies marked with this feature. Silurian, Devonian, and Carboniferous.

BIBL. Jones, *Mem. Geol. Surv. Edinb.* 1861, 137; *Ann. N. H.* 1879, iv. 183.

ENTOMONE'IS, Ehr. = *Amphiprora,* pt.

ENTOMOSTE'GIA. — One of D'Orbigny's orders of Foraminifera, having the chambers in two rows, alternate, coiled into a spiral. This alternation of chambers, however, in the coiled Foraminifera arises from very different modes of growth, and is not a group-character. It is due:—1, to bilateral asymmetry (*Cassidulina*); 2, to lateral elongation and intercalation of the chambers in *Robertina* (*Bulimina*); 3, to extreme alar division with interdigitation of the chambers on one face (*Amphistegina*); 4, to irregular growth of semi-annular chambers (*Heterostegina*); and 5, to tent-like cavities under umbilical flaps (*Asterigerina*).

ENTOMOS'TRACA.—A division of the class Crustacea.

Char. Free; freshwater or marine; body more or less distinctly jointed, mostly contained in a horny, leathery, or brittle shell or carapace, formed of one or more pieces, often bivalve; branchiæ attached either to the jaws or legs; legs jointed, and more or less ciliated; development accompanied by a regular moulting or change of shell, sometimes amounting to metamorphosis.

Many of the Entomostraca are very common in ponds, pools, and other collections of water. When examined with the naked eye, in a bottle or glass containing the water, they appear as minute specks, generally in active and often in jerking motion.

The shell is often beautifully transparent, sometimes spotted with pigment, variously striated, reticular, or notched, sometimes spinous or tuberculated. It consists of chitine impregnated with a variable amount of carbonate of lime, which is sometimes so great as to render it brittle, and to cause copious effervescence on the addition of a dilute acid; and when boiled it turns red, like the shell of a lobster. It varies in structure, sometimes consisting of two valves, united at the back, resembling the bivalve shell of a mussel; at others it is simply folded at the back so as to appear bivalve, without really being so; or it consists of a number of rings or segments. It often presents a reticular appearance resembling that of a cell-structure.

The body itself, which is more or less intimately connected with the shell, is mostly divided into numerous segments. The head is furnished with one or two pairs of antennæ; the superior or anterior are usually smallest, and in some genera easily overlooked (Pl. 20. fig. 28 *a*); sometimes one or both of them are furnished in the male with a hinge-joint, allowing considerable flexure, so as to permit of its grasping the female (Pl. 20. fig. 8 *a*, of male; 9 *a* of fenale); sometimes they are long, and provided with a tuft of filaments (Pl. 20. figs. 17, 18); at others they are simply long, and filiform or setaceous (fig. 38). In some Cypridinidæ and Conchœciidæ, the upper antennæ become organs of special sense (smell or hearing), being clothed with toothed club-shaped appendages, which arise directly from the antennæ (*Conchœcia*), or from its bristle-shaped appendages (*Cypridina*). The inferior pair or posterior antennæ vary in size and structure like the former, being sometimes large and branched (fig. 28 *b*), and serving to row the animals through the water, at others resembling legs (figs. 5, 17, &c.). In some genera they are furnished with curious appendages, effecting the purpose of the hinge-jointed superior antennæ. In some, again (Cytheridæ), the lower antennæ (Pl. 19. fig. 37) are armed with a long curved 2- or 3-jointed urticating seta (*b*), connected at its base by a duct with a vesicular gland situated in the anterior part of the body (*a*). An external stalked vesicle is also sometimes found attached to this antenna.

The eyes are usually large, the pigment black or red, and the muscles and the nervous branches distributed to them from the cephalic ganglion very distinct.

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At particular seasons of the year, the ova in certain species are furnished with thick capsules, and imbedded in a dark opaque substance presenting a minutely cellular appearance, and occupying the above-mentioned interspace between the body of the animal and the back of the shell (fig. 37 *a*). This is called the ephippium, and the ova ephippial or winter ova (EGGS).

When first hatched, the young (fig. 16) differ very strikingly in form and structure from the adults (figs. 8, 9).

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The following systematic arrangement comprises the most common genera and species. Numerous others are described, Brady enumerating 67 genera of the Copepoda only; these are briefly mentioned under the individual heads.

Legion 1. *Lophyropoda.* Branchiæ attached to the organs of the mouth; legs few, not exceeding five pairs, serving for locomotion, articulation mostly more or less cylindrical; antennæ two pairs, one pair used as organs of motion.

Order 1. **Ostracoda.** Shell consisting of 2 valves, entirely enclosing the body; feet 1–3 pairs, adapted for progression; no external ovary.

Sect. 1. PODOCOPA. Inferior antennæ simple, subpediform, geniculate, clawed at the end. (Includes all the freshwater and most of the marine Ostracoda.)

Fam. 1. CYPRIDÆ. Superior antennæ mostly 7-jointed, with a dense brush of long setæ; eye usually single; feet 2 pairs, the last bent up between the valves; abdominal rami 2, elongate, clawed at end.

Gen.: *Cypris* (Pl. 20. figs. 5 & 19), *Candona*, *Cypridopsis*, *Paracypris*, *Aglaia*, *Notodromas*, *Pontocypris*, *Argillœcia*, *Bairdia*, *Macrocypris*, and *Chlamydotheca*.

Fam. 2. CYTHERIDÆ. Superior antennæ 5–7-jointed, setigerous or spinous; inferior 4–5-jointed, without a brush; feet 3 pairs, ambulatory; post-abdomen rudimentary, consisting of 2 very small lobes. (Comprises most of the marine species, and almost all the numerous fossil species.)

Gen.: *Cythere* (Pl. 20. fig. 26), *Limnocythere*, *Cytheridea*, *Eucythere*, *Ilyobates*, *Loxoconcha*, *Xestoleberis*, *Cytherura*, *Cytheropteron*, *Bythocythere*, *Cytherideis*, *Sclerochilus*, and *Paradoxostoma*.

Sect. 2. MYODOCOPA. Inferior antennæ 2-branched: one branch rudimentary, the other powerful, many-jointed, with long natatory setæ; mandibular palp very large, subpediform, geniculate, not branchial. Post-abdomen with 2 broad plates, clawed.

Fam. 3. CYPRIDINIDÆ. Feet 1 pair; vermiform, annulated, long; mandibles obsolete; second pair of jaws with a large branchial plate; eyes, 2 compound, 1 simple.

Gen.: *Cypridina*, *Asterope*, *Bradycinetus* (*Eurypylus*), *Philomedes*, *Cylindrole-*

beris (*Cypridella, Cyprella, Entomis?,* fossil).

Fam. 4. ENTOMOCONCHIDÆ.
Gen.: *Heterodesmus, Entomoconchus.*

Fam. 5. CONCHŒCIDÆ. *Feet 2 pairs, posterior rudimentary; mandibles distinct; eyes none.*
Gen.: *Conchœcia, Halocypris.*

Sect. 3. CLADOCOPA. Inferior antennæ 2-branched, both branches well developed, natatory; upper antennæ natatory, not geniculate, with a lash of long setæ; mandibles distinct, palp short; 2 pairs of thoracic appendages—anterior large, natatory, posterior membranaceous and branchial.

Fam. 6. POLYCOPIDÆ. *Char.* Those of the section.
Gen.: *Polycope.*

Sect. 4. PLATYCOPA. Lower antennæ 2-branched, flattened; branches few-jointed, with numerous setæ. Superior antennæ strong, geniculate, shortly spiniferous; mandibles small, palp large; 3 pairs of thoracic appendages, all maxilliform; first and second pairs of jaws with a large branchial plate.

Fam. 7. CYTHERELLIDÆ.
Gen. *Cytherella.*

Order 2. **Copepoda.** Shell jointed, forming a buckler, enclosing the head and thorax; legs five pairs, mostly adapted for swimming; ovary external.

Fam. 1. CYCLOPIDÆ. Head consolidated with the thorax; foot-jaws two pairs, generally small; fifth pair of legs rudimentary; eye single; both superior (larger) antennæ in the male furnished with a swollen hinge joint.
Cyclops. Foot-jaws large and strong, branched; ovaries double (Pl. 20. figs. 8, 9).
Canthocamptus. Foot-jaws small, simple; ovary single (Pl. 20. fig. 6).
Arpacticus. Foot-jaws stout, terminated by a claw; ovary single.
Alteutha. Foot-jaws small, simple; body flat; a strong falciform appendage to the fifth segment of the body on each side (Pl. 19. fig. 3).
Tachidius, Dactylopus, Delavallia.

Fam 2. DIAPTOMIDÆ. Head consolidated with the first joint of thorax; foot-jaws three pairs, well developed; last pair of legs differing in structure from the others, and differing from each other in the two sexes; eye single, sometimes pedunculated in the male; right antenna only with the swollen hinge-joint in the male.
Diaptomus. Cephalothorax and abdomen each of five segments (Pl. 20. fig. 38).
Temora. Cephalothorax of five, abdomen of three segments.
Anomalocera. Cephalothorax of seven, abdomen of four segments (Pl. 19. fig. 6).
Dias.

Fam. 3. CETOCHILIDÆ. Head consolidated with first joint of thorax; foot-jaws three pairs, strongly developed; eyes two; right antenna only with the hinge-joint in the male.
Cetochilus (Pl. 19. fig. 21).
Notodelphys. Provisionally (Pl. 19. fig. 22).

Legion 2. *Branchiopoda.* Branchiæ attached to the legs; legs from four to sixty pairs.

Order 1. **Phyllopoda.** Legs from eleven to sixty pairs in number, joints foliaceous and branchiiform, chiefly adapted for respiration and not motion; eyes two or three, sometimes pedunculated; antennæ one or two pairs, neither adapted for swimming.

Fam. 1. BRANCHIPODIDA. Body not enclosed in a carapace or shell; antennæ two pairs, the inferior horn-like, and with prehensile appendages in the male; legs eleven pairs.
Artemia. Tail simply bilobed; no appendages at the base of the cephalic horns.
Branchipus. Tail formed of two plates, cephalic horns with fan-shaped appendages at the base (Pl. 20. fig. 3).

Fam. 2. ASPIDOPHORA. Body enclosed in a shell; antennæ one or two pairs; legs more than eleven pairs.
Apus. Shell flat, buckler-like; antennæ one pair, small; eyes sessile.
Nebalia. Shell folded at the back; an-

tennæ two pairs, large; eyes stalked (Pl. 19. fig. 28).

Fam. 3. Dithyrida. Bivalve.
Limnadia, Estheria, Limnetis.

Order 2. **Cladocera.** Legs four to six pairs, chiefly branchial; eye single, and very large; antennæ two pairs, inferior large, branched and adapted for swimming.

Fam. 1. Daphniadæ. Superior antennæ small; inferior large, two-branched; legs five or six pairs, all enclosed within the carapace; eye single, large.

* (Daphnina.) Legs five pairs; inferior antennæ two-branched, one branch four-, the other three-jointed.

Daphnia. Head produced below into a beak; superior antennæ very small (Pl. 20. fig. 28).

Moina. Head rounded and obtuse; superior antennæ large (Pl. 19. fig. 26).

Macrothrix. Head beaked, beak directed forwards; superior antennæ one-jointed, hanging from the beak (Pl. 19. fig. 25).

Bosmina. Head terminating in a sharp direct beak; superior antennæ long, many-jointed, projecting from end of beak (Pl. 20. fig. 2).

Drepanothrix, Lathonura, Acantholeberis, Ilyocryptus.

** (Sidina.) Legs six pairs; inferior antennæ two-branched; a row of spines arising from the edge of larger branch; superior antennæ of moderate size.

Sida. One branch of inferior antennæ three-, the other two-jointed (Pl. 19. fig. 27).

Daphnella. Both branches two-jointed (Pl. 20. fig. 27).

Fam. 2. Polyphemidæ. Inferior antennæ two-branched, one branch four-, the other three-jointed; lower part of shell forming a large vacant space for containing the ova and young; eye very large; legs four pairs, not contained within the shell.

Polyphemus. Tail-like abdomen projecting outside the shell; freshwater (Pl. 19. fig. 29).

Evadne. Abdomen scarcely projecting from the shell; marine (Pl. 19. fig. 30).

Fam. 3. Lyncidæ. Superior antennæ very short; inferior of moderate size, branched, each branch three-jointed; legs five pairs; eye single, with a black spot in front; intestine convoluted, having one complete turn and a half.

Eurycercus. Shell subquadrangular, abdomen forming a flat, densely serrated plate (Pl. 20. fig. 39).

Chydorus. Nearly spherical; beak very long, sharp, and curved; inferior antennæ very short (Pl. 20. fig. 7).

Camptocercus. Ovoid; abdomen long, slender, and very flexible, serrated (Pl. 20. fig. 4).

Acroperus. Somewhat harp-shaped, with an anterior inferior obtuse angle; inferior antennæ rather long (Pl. 19. figs. 1, 2).

Alona. Quadrangular, striated or grooved longitudinally; inferior antennæ short (Pl. 19. figs. 4, 5).

Pleuroxus. Gibbous above and anteriorly; obliquely truncate below; first pair of legs very large (Pl. 19. fig. 32).

Peracantha. Oval, lower end with a curved posterior point, fringed inferiorly and antero-superiorly with strong hooked spines (Pl. 19. fig. 31).

Monospilus.

See Crustacea and Siphonostoma.

Bibl. Baird, *Br. Entom.*; M.-Edwards, *Crustac.* iii.; Straus, *Mém. Mus.* 1819, v. 380, and 1821, vii. 33; Koch, *Deutschl. Crustac.*; Desmarest, *Crustac.*; Jones, *Entom. Cretac. Form.* (*Palæont. Soc.*); *Entom. Tert.*, and *Foss. Estheriæ*; Zencker, *Müller's Archiv*, 1851 (*Micr. Tr.* i. 273); Morris, *Brit. Foss.* 98; Lubbock, *Linn. Tr.* xxiii. 176, and xxiv. 197; Dana, *Classif. Crust.* 1853, *Report on Crust. U. S. Exped.* 1855; Baird, *Ann. N. Hist.* 1862, ix. 132, and x. 1; Grube, *Esth. u. Linnad., Archiv Nat.* xxxi. 1865; Plateau, *Ann. N. H.* 1869, iii. 12; Schœdler, *Cladocera* (3 pl.), 1863; Brady, *Ann. N. H.* 1864, xiii. 59 (*New Ostracoda*); 1868, ii. (*Ostr. from Scandinavian Seas, Mauritius, &c.*); 1869, iii. 45; id. *Linn. Tr.* 1868, xxvi. 353 (*Monogr. Ostracoda*); and *Copepoda* (*Ray Soc.*); Norman and Brady, *Monogr.* 1867; Sars, *Oversigt af Norges Mar. Ostrac.* 1865; Lilljeborg, *De Crustaceis*, 1853; Zencker, *Müll. Arch.* 1850 (*Cypris*); ibid. 1851; id. *Arch. Naturg.* 1854; Hartog, *Jn. Mic. S.* 1880, 243; Brady and Robertson, *Ann. N. H.* 1872, ix. 48; & *Tr. Palæontog. Soc.* xxviii.; Claus, *Copepoda*, 1881; and the Bibl. of the genera.

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Char. Free; freshwater or marine; body more or less distinctly jointed, mostly contained in a horny, leathery, or brittle shell or carapace, formed of one or more pieces, often bivalve; branchiæ attached either to the jaws or legs; legs jointed, and more or less ciliated; development accompanied by a regular moulting or change of shell, sometimes amounting to metamorphosis.

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The body itself, which is more or less intimately connected with the shell, is mostly divided into numerous segments. The head is furnished with one or two pairs of antennæ; the superior or anterior are usually smallest, and in some genera easily overlooked (Pl. 20. fig. 28 *a*); sometimes one or both of them are furnished in the male with a hinge-joint, allowing considerable flexure, so as to permit of its grasping the female (Pl. 20. fig. 8 *a*, of male; 9 *a* of female); sometimes they are long, and provided with a tuft of filaments (Pl. 20. figs. 17, 18); at others they are simply long, and filiform or setaceous (fig. 38). In some Cypridinidæ and Conchœciidæ, the upper antennæ become organs of special sense (smell or hearing), being clothed with toothed club-shaped appendages, which arise directly from the antennæ (*Conchœcia*), or from its bristle-shaped appendages (*Cypridina*). The inferior pair or posterior antennæ vary in size and structure like the former, being sometimes large and branched (fig. 28 *b*), and serving to row the animals through the water, at others resembling legs (figs. 5, 17, &c.). In some genera they are furnished with curious appendages, effecting the purpose of the hinge-jointed superior antennæ. In some, again (Cytheridæ), the lower antennæ (Pl. 19. fig. 37) are armed with a long curved 2- or 3-jointed urticating seta (*b*), connected at its base by a duct with a vesicular gland situated in the anterior part of the body (*a*). An external stalked vesicle is also sometimes found attached to this antenna.

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In some genera, as *Cunthocamptus*, *Cyclops*, and *Diaptomus*, the respiration is exclusively anal; the water being drawn into and expelled from the rectum at intervals, as in many aquatic larvæ of insects.

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xxiv. 253; Thomas, *Jahr. vviss. Bot.* iv. 33; Pfitzer, *ibid.* vii. 561, and viii. 17; De Bary, *Bot. Zeit.* 1871; Sachs, *Bot.* 1874; Henfrey-Masters, *Bot.* 1878.

EPIPYX'IS, Ehr.—A genus of Flagellate Infusoria, of the family Dinobryina.

Char. Fixed by a pedicle; eye-spot absent; no cilia nor appendages.

E. utriculus (Pl. 30. fig. 50). Carapace urceolate; body filled with yellowish granules; on *Confervæ*; length 1-650″.

Probably the young state of *Dinobryon sertularia*, like which it contains a disk-shaped nucleus.

Bibl. Ehrenb. *Infus.* 123; Kent, *Infus.* 409.

EPISTY'LIS, Ehr.—A genus of Infusoria, of the family Vorticellina.

Char. Pedicle rigid, not contractile, simple or branched; all the bodies of the animals of the same form.

Claparède and Lachmann refer the species of *Opercularia* to this genus.

Stein has pointed out the occurrence of the encysting-process in the species of this genus; and indicates the presence of a lid-like discoidal process, protrusible from the orifice, as in *Vorticella*, furnished with vibratile cilia; but this does not occur in all the species admitted by Ehrenberg. The species are numerous, and mostly attached to aquatic animals or algæ. Clap. & Lachm. admit 19 species.

E. anastatica (Pl. 30. fig. 51 *a*, *c*). Body small, conical, not plicate, anterior margin large and projecting; pedicle dichotomous, smooth, or covered with minute or foreign bodies; entire length 1-144 to 1-14″; of single body, 1-288″.

E. grandis. Body large, broadly campanulate; pedicle decumbent, slender, smooth, laxly branched, not jointed, forming large tufts; length of body 1-140 to 1-120″.

E. vegetans (Anthophysa *Müller*i, Duj.).

Bibl. Ehrenb. *Infus.* 279; Stein, *Inf.*; Claparède and Lachmann, *Inf.* 107; Tatem, *Mic. Tr.* 1868, 31; Kent, *Inf.* 700.

EPIT'EA, Fr. See Urredinei, Phragmidium, and Melampsora.

EPITHE'LIUM. — The membranous layer lining the various internal cavities, and covering the internal free surfaces of animal bodies, as the mucous canals and cavities, and their involutions forming the glands and ducts, the serous cavities, the vessels, &c.

It consists of one or more layers of nucleated cells, the form and arrangement of which are very variable. They are either round, polygonal, spindle-shaped, cylindrical, or conical; and are united by a small quantity of intercellular substance. They contain a clear or granular nucleus, with one or more nucleoli. In some instances they contain granules of black pigment or melanime.

Three kinds of epithelium are usually distinguished; but intermediate forms are also met with.

Pavement- or tessellated epithelium. This consists of roundish, oval, or polygonal flattened cells, about 1-2000 to 1-500″ in diameter, and containing nuclei with nucleoli. It occurs upon the surface of the serous and synovial membranes; the membrane of the aqueous humour, the choroid, the capsule of the lens, the retina, and the conjunctiva of the ball of the eye; the cavity of the tympanum; the lower half of the pharynx, the œsophagus, the endocardium; some veins; many glands and ducts, as the racemose, the sudoriparous and ceruminous glands; the hepatic ducts; the vagina and female urethra; the bladder, uterus, pelvis, and tubules of the kidneys; and the air-cells of the lungs. In the arteries and many veins the cells are spindle-shaped.

Cylindrical epithelium. In this form the cells are either cylindrical, conical, or pyramidal, about 1-1000″ in length, and so situated that the axis of the epithelial scales or cells is at right angles to the surface upon which they are placed. Sometimes the subjacent cells are of a rounded form.

Cylinder-epithelium is met with in the mucous membranes, in Lieberkühn's follicles, and the ducts of the gastric as well as those of all other glands opening into the intestine; in the lachrymal and the mammary glands; the male urethra; the vas deferens; the vesiculæ seminales, the prostatic ducts, with Cowper's and the uterine glands.

Ciliated epithelium. In this the form and arrangement of the cells is much the same as in the last; but their free ends are furnished with numerous vibratile cilia (Pl. 49. fig. 13).

Ciliated epithelium occurs in the larynx, trachea, and bronchi; the nares and pharynx above the level of the base of the nasal bones, and the cavities opening into them; the inner surface of the membrana tympani, the Eustachian tube; the uterus, the Fallopian tubes; the lachrymal sac and nasal duct; the palpebral conjunctiva; and the ependyma.

In most epithelia, the cells and their nuclei are readily distinguished; but in others, especially those of the vessels and serous membranes, staining with magenta, &c., is required to render the nuclei distinct, and silvering to bring out the cell-boundaries. (See STAINING.)

In many cases, intervals are left between the epithelial cells, usually at the points where several cells meet; these are called stomata. They are often connected with the lymphatic system. See STOMATA.

The epithelium covering the outer surface of the body forms the *epidermis* or *cuticle*.

Further particulars of the special forms of the cells are given under the heads of the organs or tissues in connexion with which the epithelia are found.

BIBL. Kölliker, *Mikr. An.* and *Handb. d. Gewebel.*; Valentin, *Wagner's Handb. d. Phys.*, art. *Flimmerbewegung* and *Epithel.*; Henle, *Allgemein. An.*; Todd and Bowman, *Phys.*; Frey, *Histologie*, 1876, 153 and the full literature.

EPITHELIUM OF PLANTS. See EPIDERMIS of Plants.

EPITHE'MIA, Brébisson.—A genus of Diatomaceæ.

Char. Frustules single, attached by a part of the surface to other bodies; valves with transverse or slightly radiant striæ, some of them not resolvable into dots.

Frustules prismatic, quadrangular, mostly curved, sometimes slightly undulating in the side view; one face of front view (that by which they are attached) flat or concave, the other convex and broader than the former, so that the transverse section forms a trapezoid. Between, or corresponding with the transverse striæ, which are not resolvable into dots, are often transverse rows of dots or depressions.

The species are numerous. Freshwater and marine. Rabenhorst describes 21 European. Conjugation has been observed in three of them.

E. turgida (Pl. 16. fig. 32: *a*, side view; *b*, front view). Front view oblong, slightly dilated towards the middle; side view somewhat convex, gradually attenuated towards the very obtuse ends. Freshwater; length 1-240″. In conjugation, Pl. 10. fig. 6 *a*, *b*, *c*, *d*, *e*.

E. gibba (Pl. 51. fig. 6). Straight; inflated in the middle on each side in front view; valves gibbous in the middle on one side; freshwater and fossil; length 1-140″.

BIBL. Kützing, *Bacillar.* 33, and *Sp. Alg.* 1; Smith, *Brit. Diatom.* i. 13; Rabenhorst, *Sp. Alg.* i. 62.

EPOCH'NIUM, Lk.—A genus of Torulacei (Hyphomycetous Fungi), forming a stratum over larger fungi or dead twigs, consisting of a mycelium of irregularly branched and anastomosing filaments, which bear, on short lateral branchlets, oblong or globular septate spores, which soon fall off and lie among the mycelium-threads.

E. fungorum is very common, forming a dark-green stratum over *Thelephoræ*; *E. macrosporoidium* was found by Berkeley on a dead twig, apparently of red currant.

Sphæria Epochnii, B. & Br., has been found on *Epochnium fungorum*; and it is very probable that it is the perfect state of a conidiiferous mycelium.

BIBL. Berk. in *Brit. Flora*. vol. ii. pt. ii. 352; *Ann. N. H.* i. 263, pl. 8. fig. 14.

EQUISETA'CEÆ and EQUISE'TUM.—This is a very distinctly characterized family of Flowerless Plants, consisting of a single genus, the *Equiseta*, or Horse-tails, which are immediately recognized, when one species is known, by their peculiar aspect and habit of growth. The stems and branches are alike tubular, and present in almost all cases a rather coarsely (perpendicularly) streaked surface. The stems appearing above ground are shoots from a creeping underground stem (fig. 201), which differs from the erect stems in being of a deep brown colour and solid, in giving off root-fibrils, and sometimes in being covered with hairs. The erect stems are either *barren* or *fertile*; in the *barren stems* the joints become gradually thinner upwards from a certain point, at last tapering off to an obtuse apex; the *fertile stems* bear a kind of club-shaped head, resembling in some degree the male cones of Coniferous trees, or more particularly those of some Cycads (fig. 201). These club-shaped bodies are the fruits or heads of sporanges.

Fig. 201.

Equisetum arvense. One half of nat. size.

The anatomical structure of the rhizome and shafts present some interesting points.

In the solid rhizome the centre is occupied by cellular tissue of tolerably strong texture; outside this, as seen in a cross section, stands a circle of air-canals, each surrounded by a ring of vascular bundles; next comes a complete circle of vascular bundles composed almost wholly of annular ducts; between this vascular ring and the outside lies parenchyma like that in the centre, traversed by another concentric circle of air-canals; and immediately beneath the epidermal cells there exists a layer of compact blackish-brown parenchymatous cells. When the rhizome is coated with hairs, these are formed by development of the epidermal cells into slender tubular processes. Tracing the solid rhizome up towards the points where the erect stems arise, the central cellular substance is gradually lost, and the outer portions are modified in their arrangement. The distribution of the air-canals and the vascular bundles varies; in some cases, the peculiarities are even regular enough to afford specific characters. The surface is clothed by an epidermis composed of elongated cells often elevated into papillæ, and especially remarkable for the quantity of silica deposited in their walls. This epidermis is studded with variously formed stomata usually arranged in double lines; and the forms of the epidermal cells and stomata are perfectly preserved in the siliceous ash which remains after burning off the organic substance from a portion of this EPIDERMIS, offering a curious microscopic object. Between the epidermis and the central cavity, in a cross section lie—first, a layer of thick-walled elongated cells, within which, in the angular-stemmed species, comes a circle of masses, usually crescentic, of cellular tissue containing chlorophyll. Next come usually two concentric rings of air-canals, those of the inner circle being individually surrounded by annular ducts; and, moreover, in some species a circle of 6–10 vascular bundles separates the inner from the outer circle of air-canals; the structure of the bundles is variable, exhibiting annular, spiral, and reticulated ducts. The inner circle of air-canals lies in the parenchyma which bounds the central cavity. At each joint this cavity is cut off by a diaphragm composed of three layers, in the intermediate of which, of brownish cellular tissue, lies an anastomosing ring, where all the vascular bundles coalesce and give off branches to the sheath (and branches when present).

The club-shaped fruit-spikes consist of a central axis forming the last joint of the stem, on which are attached numerous mushroom-shaped groups of *sporanges*, the stalks of each adhering to the central axis, so that we only see the upper side of the cap externally (figs. 202, 203). This has an angular border; and the adjacent sporanges being very close, the outer ends of these bodies cause a tessellated appearance of the whole in the earlier stages of development. As the sporanges ripen, they separate more from each other; and when one is removed (fig. 204), it is seen to possess a number of little pouch-like cases under the overhanging outer portion and round the stalk; these pouches burst by a perpendicular slit inwards, and discharge the spores.

Fig. 202. Fig. 203.

Fig. 204.

Fig. 205.

Equisetum arvense.

Fig. 202. Fruit-spike. Magnified 3 diams.
Fig. 203. A spike halved vertically. Magn. 3 diams.
Fig. 204. A stalked group of sporanges removed from preceding. Magn. 25 diams.
Fig. 205. A spore with elaters uncoiling. Magn. 200 diams.

The *spores* of the *Equiseta* are very remarkable, and unlike any other known vegetable structure. They are roundish cells, with *apparently* only *one* coat; for the outer coat splits up into four thread-like processes (*elaters*), thickest and rather clubbed

at their free ends. While the spore remains in the sporange, these fibres are rolled round the spore; but when the spores are discharged, the coiled fibres uncurl (fig. 205), and assist in scattering the spores, their elasticity causing them to spring out.

The *Equiseta* possess only this one kind of spore; and the germination is analogous to that of the Ferns, in which likewise only one kind of spore exists. The membrane of the spore pushes out a pouch-like process, which after a time becomes cut off by a septum; the end-cell grows on and multiplies in both directions, until a lobulated prothallium is produced; on this arise *archegonia* and *antheridia*, in distinct individuals, the archegonial prothallia being larger than the antheridial, and resembling in all essential respects those produced on the corresponding structure in the FERNS. The antheridia are formed on the ends or the margins of the male prothallia. The spermatozoids are larger than those of other Cryptogamia; they have 2 or 3 coils, the posterior thickened portion being furnished with an appendage, supposed to consist of an undulating membrane.

After the fertilization of an archegonium, the germ-cell contained in it becomes developed as an embryo, and a new Equisetum-stem of the ordinary structure springs up (fig. 206), forming a creeping rhizome with

Fig. 206.

Equisetum arvense.
Young stem arising from a prothallium.
Magnified 15 diameters.

upright fistular shafts, resembling the parent plant from which the spores were derived.

The family Equisetaceæ is represented in existing vegetation by a single genus, containing only herbaceous plants. The Equisetaceæ of former ages were far more important as regards size.

BIBL. Francis's *British Ferns*, 5th ed. 1855; Thuret, *Ann. Sc. Nat.* 3 sér. xi. 5; Milde, *Bot. Zeit.* viii. 448, and x. 537, *Linnæa*, xxiii. 545; Hofmeister, *Vergleich. Unters.* 1851, *Verh. k. Sächs. Akad. d. Wiss.* iv. 123; Bischoff, *Krypt. Gewächse*, Heft 1, 27, pls. 3, 4, 5, *Botan. Zeit.* xi. 97; Pringsheim, *Bot. Zeit.* xi. 241; Sanio, *Bot. Zeit.* xiv. 177, xv. 657; Milde, *Nova Acta*, 1867, xxxv.; Nägeli and Leitgeb, *Näg. Beit.* iv. 1867; Janczewsky, *Bot. Zeit.* 1872, 420; Tieghem, *Ann. Sc. Nat.* 5 sér. xiii.; Sachs, *Bot.* 389.

EREBONE'MA, Röm.—A supposed genus of Kützing's family Leptomiteæ. Some imperfect filamentous organism, probably belonging to a Fungus.

BIBL. Römer, *Deutschl. Alg.* 70; Kützing, *Sp. Alg.* 157.

EREMÆ'US, Koch.—A genus of Oribatidæ (Acarina).

Char. Cephalothorax without lamellæ; tarsi with heterodactyl claws. Allied to *Hoplophora*. (Murray, *Ec. Ent.* 222, fig.)

ERE'MOSPHÆRA. See CHLOROSPHÆRA.

ERE'TES, Werneck.—A genus of Infusoria, of the family Cryptomonadina.

Char. Those of *Phacelomonas* with a carapace.

One species: the spores of an Alga?

BIBL. Werneck, *Ber. Berl. Ak.* 1844, 377.

ERGOT and ERGOTÆ'TIA. See CLAVICEPS.

ERIN'EUM, Pers.—A supposed genus of Fungi, really consisting of abnormal developments of the cells of the epidermis of the trees upon which they are supposed to be parasitic; or galls, produced by the action of Phytoptidæ. They occur chiefly upon the Amentaceæ, Aceraceæ, and Rosaceæ (Apple-trees, Plum-trees, &c.).

See TAPHRINA.

BIBL. Fries, *Syst. Mycol.* iii. 521; Berkeley, *Lindley's Veg. Kingdom*, art. *Fungales*; Murray, *Ec. Entom.* 331.

ERIODER'MA, Fée.—A genus of tropical Lichens, tribe Lecanorei, externally resembling the Peltigeræ; consisting of a green membranaceous thallus, spreading from the centre, hairy above, and with woolly anastomosing nerves beneath. Apothecia marginal, with hispid hairs on the margin underneath.

BIBL. Fée, *Crypt.* 145, pl. 34. fig. 2.

ERIOSO'MA. See APHIDÆ.

ERIOS'PORA, Berk. & Br.—A genus of Sphæronemei (Stylosporous Fungi), described (*E. leucostoma*) as forming minute brown spots upon dead leaves of the bulrush. The conceptacles are globose, and collected in numbers on the stroma, bursting by a single common (white-bordered) pore to discharge the spores (stylospores), which are filiform and very slender, and arise in fours from a sporophore. (See CONIOMYCETES.)

BIBL. Berk. and Br. *Ann. N. H.* 1850, v. 455, pl. 11. fig. 1.

ERUPTIONS, CUTANEOUS.—The scales, crusts, scabs, contents of vesicles, pustules, &c. formed in various diseases of the skin, usually consist of epidermic cells alone, more or less flattened or otherwise altered, or of these with the ordinary products of inflammation. Granules of soot are frequently found, in London at least, mixed with the above elements; and these were once regarded as the microzymes of small-pox. Fungi exist in the crusts of some skin-diseases, as FAVUS, &c. The itch-insect, SARCOPTES, must not be forgotten, nor DEMODEX. See PARASITES.

ERVIL'IA, Duj. (*Ægyria*, Cl. & Lachm.). —A genus of Infusoria, of the family Ervilina.

Char. See the family. Marine.

E. legumen = *Euplotes monostylus*, E. (Pl. 30. fig. 52; *b*, side view). Body with two ventral contractile vesicles; length 1-650 to 1-420″.

3 other species.

BIBL. Duj. *Infus.* 455; Clap. & Lachm. *Inf.* 288.

ERVILI'NA, Duj. (Dysterina, Cl. & Lachm.).—A family of Infusoria.

Char. Body oval, more or less depressed, entirely or partly ciliated, with a tail-like foot, usually also with a persistent membranous carapace.

Genera:

Carapace present.
  Composed of two distinct valves ..... *Iduna.*
  Composed of two united valves.
    Valves united behind and below only ... *Dysteria.*
    Valves united all down the back ..... *Ervilia.*
Carapace absent..... *Huxleyia.*

Dujardin questions whether *Urocentrum*, E., does not belong to this family.

BIBL. Duj. *Infus.* p. 454; Clap. & Lachm. *Infus.* p. 278.

ERY'SIPHE, Hedw. fil.—A genus of Pyrenomycetes (Ascomycetous Fungi), consisting of little mildews overgrowing the leaves of living plants, mostly Dicotyledons. The mycelium is formed of slender ramified filaments, which spread and form an entangled web over the epidermis of the infected plant, sending into the substance sucker-like processes or haustoria, by which nourishment is obtained from the juices of the leaf. From the creeping mycelium arise numerous upright short-jointed filaments, the last one or more of the cells or joints of which swells so as to render the erect filament clavate or moniliform. These expanded cells become detached with the greatest readiness, and, when they fall upon the supporting leaf, germinate and produce new mycelium threads. In this state the *Erysiphæ* cannot be distinguished from the genus *Oidium*; and as this state is succeeded in most cases by the true conceptacle of the genus *Erysiphe*, the *Oidia* (such as *O. Tuckeri*, the Vine-fungus), which grow under the same circumstances, but do not produce conceptacles, are regarded by most authors as imperfect *Erysiphæ*. (See OIDIUM, Pl. 26. figs. 12–14.) When the mycelium of an *Erysiphe* is developed late in the year, it seldom produces any thing but the ovate cells (*conidia*); but if developed early in the summer, the mycelium grows at certain points into denser white patches (*receptacles*, Lév.), from which arise the *conceptacles*, which are fertilized by pollinodia, as in *Eurotium*. These are small globular sacs, composed of a double layer of cells; from the base of the outside of the sac arise a number of radiating filaments, simple or branched (*appendicles*, Lév.), while in its interior are developed one or many sacs, (*asci*, *sporanges*, Lév.), in each of which are produced mostly eight sporidia. In addition to the above, a third form of fruit occurs, in which the *conidium* becomes transformed into a sac (*pycnidium*) filled with minute spores. Tulasne has figured a second form, apparently of conidia, in *Phyllactinia guttata*.

Léveillé, in an elaborate essay on this genus, has subdivided it into six genera, which may perhaps be better taken as subgenera, and may be distinguished in the following manner:—

Conceptacles with one ascus.

Appendicles dichotomously branched... *Podosphæria.*
  „ floccose..... *Sphærotheca.*

Conceptacles with many asci.

  „ aciculate ..... *Phyllactinia.*
  „ uncinate ..... *Uncinula.*
  „ dichotomously branched... *Microsphæria.*
  „ floccose..... *Erysiphe.*

Podosphæria. The Hawthorn-blight and the Plum-blight belong to this division.

Sphærotheca. The Rose-mildew, *E. pannosa*, auct., belongs to this group, and is distinguished from *E. macularis*, Wallr. (*S. Castagnei*, J. Lév.), the Hop-mildew, by the appendicles of the former being white, while those of the latter are coloured. The mycelium of the rose-mildew seems to be the same thing as *Oidium leucoconium*, Desm. The similar structure of the Hop-mildew has been described and figured (from Dr. Plomley's drawings) in the Trans. of the Horticultural Society. He was the first to discover the conversion of one of the oidioid cells into pycnidia.

Phyllactinia. *E. guttata*, Schlecht., common on the hazel and other trees and large shrubs, is distinguished from the other forms of *Phyllactinia* by having a bulbous base to its appendicles, which contain 2 to 4 sporidia.

Uncinula. *E. adunca*, Schlecht., is referred here; its distinctive character is the existence of the hooked appendicles. Found on willows. *E. bicornis*, Lk., occurring upon maples &c., has eight spores.

Microsphæria. *E. penicillata*, occurring on *Viburnum Opulus*, &c. Several species occur in this country, of which one of the best-known is *M. penicillata*. The characters of the appendicles, which are dichotomously branched at the tip, are the same as those of *Podosphæria*; but there are many asci, instead of one only.

Erysiphe. *E. Pisi*, Grev., is *E. Martii* of Léveillé, distinguished by its globose, many-spored asci and the simple or irregularly branched appendicles. *E. tortilis*, Lk., has coloured appendicles ten or more times the length of the conceptacle. It grows on *Cornus sanguinea*, the Dogwood tree. *E. communis*, Lév., is not very well characterized; it has coloured appendicles, which are only twice or thrice as long as the conceptacle; the asci vary from four to eight, as do also the spores contained in each. This species grows on a great variety of herbaceous plants, Ranunculaceæ, Compositæ, Leguminosæ, Cruciferæ, Polygonaceæ, &c.

Perhaps a doubt might be admitted whether the above subdivisions really represent more than six *species* of this genus.

Bibl. Léveillé, *Ann. Sc. Nat.* 3 sér. xv. 109, pls. 6–11; Berk., *Hook. Br. Fl.* ii. pt. 2. 325; *Tr. Hort. Soc. London*, ix. 61; Greville, *Sc. Crypt. Fl.* pls. 134, 164. figs. 2, 296; Tulasne, *Compt. Rendus*, 1853; *Ann. Sc. Nat.* 4 sér. vi. 299, and *Carpologia*, i. 1860; Cooke, *Handbook*, 645; Taylor, *M. M. Jn.* 1875, xiii. 121; De Bary and Woronin, *Beit. z. Morph.* 1870; Sachs, *Bot.* 312.

See also Oidium.

ERYTHRÆ'US, Dugès.—See Anystis.

ESCHAR'IDÆ.—A family of Cheilostomatous Polyzoa; containing the genera *Lepralia*, *Umbonula*, *Porella*, *Escharoides*, *Smittia*, *Phylactella*, *Mucronella*, *Palmicellaria*, and *Retepora*.

ESCHAROI'DES, Smitt.—A genus of Cheilostomatous Polyzoa, fam. Escharidæ.

2 species; deep water. (Hincks, *Polyzoa*, 336.)

ESPAR'TO.—The bast-fibres of a grass, *Lygeum spartum* (*Stipa tenacissima*, Linn.; *Makrochloa*, Kunth), a coarse fibrous material, extensively used in the manufacture of paper. The fibres are shorter than those of most allied substances; and the epidermic wavy margined cells are so short as to render the distinction of this material tolerably easy.

It occurs extensively in the south of Europe, in North America, and in the centre and south of Spain.

Bibl. Henfrey-Masters, *Bot.* 400; Wiesner, *Techn. Mikr.* 225 (fig.).

ESTHE'RIA, Rüppell and Straus-Dürckheim (*Cyzicus*, Audouin; *Isaura*, Joly).

A bivalved phyllopodous Entomostracon, having 24 pairs of foliaceous limbs, and ovate valves, horny, delicate, concentrically ridged, bearing from 7 to 80 lines of growth, with intermediate reticulation or other sculpturing.

26 species are known, from fresh and brackish waters of warm climates; and more than 20 fossil, Devonian to Tertiary.

Bibl. Baird, *Zool. Proc.* 1849, 87; 1852, 30; 1859, 232; 1860, 188 and 392; Rupert Jones, *Foss. Estheriæ* (*Pal. Soc.*), 1862; E. Grube, *Arch. f. Naturgesch.* 1853, xix., and 1865, xxxi.

EUAC'TIS, Kütz.—A genus of Oscillatoriaceæ (Confervoid Algæ), of the tribe Rivularieæ, consisting of little, hard, solid, elastic, mostly hemispherical bodies, from 1-2 to 2‴ in diameter, growing upon stones in the sea or rivers, &c.; concentrically zoned, composed of radiating, flagelliform, repeatedly sheathed filaments, the sheaths of which are open and slit above (Pl. 8. fig. 16), but connected together side by side, so as to form a tough gelatinous mass, not becoming incrusted with carbonate of lime. To this

genus Kützing refers *Rivularia plicata, atra,* and perhaps *applanata* of Harvey. These plants are interesting on account of the fibrous decomposition of the gelatinous sheaths.

Bibl. Harvey, *Brit. Mar. Alg.* 222, pl. 26 A (*Rivularia*); Kützing, *Sp. Alg.* 339; *Tab. Phyc.* cent. ii. pls. 74–82.

EUAS'TRUM, Ehr.—A genus of Desmidiaceæ.

Char. Cells single, compressed, deeply divided into two segments, which are generally pyramidal and furnished with circular protuberances, lobed or sinuated at the margins, and emarginate at the ends.

Ralfs describes twenty-one British species, of which the following are the most common.

* *Segments deeply lobed; end lobe distinct, cuneate, partly included in a notch between the lateral lobes.*

E. verrucosum (Pl. 14. fig. 14). Rough; segments three-lobed, lobes broadly cuneate, with a shallow notch; length 1-267″.

E. oblongum (Pl. 14. fig. 15). Smooth, oblong; segments five-lobed; lobes cuneate; emarginate; length 1-156″.

E. crassum. Smooth; segments three-lobed, subquadrilateral; end lobe cuneate; length 1-190 to 1-130″.

** *Segments sinuated; end lobe exserted and united with the basal portion by a distinct neck.*

E. didelta (Pl. 14. fig. 16; 17, empty cell). Segments with inflated base, intermediate tubercles, and notched and scarcely dilated ends; side view, four shallow lateral lobes, and one at each end; length 1-185″.

*** *End lobe indistinct; frequently a process or acute angle at the corners of the terminal portion.*

E. elegans. Oblong; ends emarginate, pouting, and rounded; length 1-890 to 1-420″.

Conjugation has been observed in several species; the sporangia are spherical, with conical tubercles, or acute or obtuse spines.

Bibl. Ralfs, *Brit. Desmid.* 78; Rabenhorst, *Fl. Alg.* iii. 179.

EUCAM'PIA, Ehr.—A marine organism, allied to the Desmidiaceæ, among which it is placed by Kützing, whilst Smith refers it to the Diatomaceæ.

It forms articulated, arcuate or spiral, fasciæform, microscopic fronds, composed of hyaline wedge-shaped frustules, with yellowish granular contents. The joints shrink in drying, and are destroyed by heat. The markings consist of dots.

E. zodiacus (Pl. 50. fig. 10). Frustules with a median excavation on each side; valves elliptical; length 1-710″.

E. britannica. Frustules not excavated; length 1-380″.

E. striata. Valves circular; endochrome green.

Bibl. Ehrenb. *Abh. Berl. Ak.* 1839, 125; Kützing, *Sp. Alg.* 191, *Bacillar.* pl. 21. fig. 21; Smith, *Br. Diat.* ii. 25; Stolterforth, *Jn. M. Soc.* 1879, ii. 835.

EUCERTYD'IUM, Ehr.—A genus of Polycystina.

E. ampulla (Pl. 39. fig. 25, front view; fig. 26, under view).

See Polycystina.

EUCHLANIDO'TA, Ehr.—A family of Rotatoria.

Char. Rotatory organ multiple, or divided into more than two lobes; a carapace present.

The carapace forms either a testa or a scutellum; various appendages are present, representing either straight bristles, curved bristles or hooks, minute horns—so-called respiratory tubes or antennæ,—and in one genus a frontal hood.

The eleven genera are thus distinguished:

Eyes absent; foot forked	*Lepadella* (*Diplax*).
Eyes present.	
Eye single (cervical).	
Foot styliform.	
Carapace depressed	*Monostyla.*
„ prismatic	*Mastigocerca.*
Foot forked.	
Carapace open beneath	*Euchlanis.*
„ closed beneath.	
Carapace with horns	*Salpina.*
„ without horns	*Dinocharis.*
Eyes two (frontal).	
Foot styliform	*Monocerca.*
„ forked.	
Carapace compressed or prismatic.	*Colurus.*
„ depressed or cylindrical.	
Head without a hood	*Metopidia.*
„ with a hood	*Stephanops.*
Eyes four; foot forked	*Squamella.*

Bibl. Ehrenb. *Infus.* p. 455.

EU'CHLANIS, Ehr.—A genus of Rotatoria, of the family Euchlanidota.

Char. Eye single, cervical; foot forked; carapace cleft or open on the ventral surface. Aquatic.

Ehrenberg describes six species, to which Gosse adds three.

E. triquetra (Pl. 43. fig. 30; fig. 31, teeth). Carapace very large, with a dorsal crest; foot without setæ; length 1-48″.

Bibl. Ehrenb. *Infus.* 461; Gosse, *Ann. N. H.* 1851, viii. 200.

EUCRAT'EA, Lamx. (*Scruparia*).—A genus of Cheilostomatous Infundibulate Polyzoa, of the family Eucratiidæ.

E. chelata (Pl. 36. fig. 24), the only species. Parasitic upon *Fuci*, crabs, and stones. (Hincks, *Polyzoa*, 11.)

EUCRATIIDÆ (Scruparidæ). — A family of Cheilostomatous Infundibulate Polyzoa.

Distinguished by the unjointed polyzoary and the uniserial cells. Polyzoary usually loosely adnate. Five genera:

Eucratea (*Scruparia*). Erect, branched, branches arising from the horn-shaped cells above or below the oblique orifice.

Hippothoa. Creeping, adherent, irregularly branched or netted, branches arising from the sides of the cells.

Salpingia (Pl. 36. fig. 25). Erect, branched; cells elongated, with trumpet-shaped processes at the base, orifice oblique, lateral.

Anguinaria (*Ætea*). Cells tubular, scattered, arising from a creeping, adherent thread.

Beania. Cells erect, scattered, with a double spinous keel on one side, and arising from a creeping, adherent, branched thread.

Bibl. Johnston, *Br. Zooph.* 288; Busk, *Mar. Polyz.* 28; Gosse, *Mar. Zool.* ii. 12; Hincks, *Polyzoa*, 11.

EUCYTHE'RE, Brady (*Cytheropsis*, Sars).—A genus of marine Entomostraca, fam. Cytheridæ.

2 species.

Bibl. Brady, *Linn. Trans.* 1868, p. 429.

EUDEN'DRIIDÆ (Tubulariidæ, pt., Johnst.).—A family of Hydroid Polypi. Characterized by the branched stem, and the terminal naked polypes, with a single whorl of tentacles surrounding the base of a trumpet-shaped proboscis.

1 genus: *Eudendrium*.

EUDEN'DRIUM, Ehr.—A genus of Hydroid Polypi, fam. Eudendriidæ (Tubulariidæ, Johnst.).

Char. Those of the family.

7 British species.

E. ramosum (*Tubularia ram.*, Johnst.) is common on oyster-shells, &c.

Bibl. Hincks, *Brit. Zooph.* 79; Johnstone, *Brit. Zooph.* 46.

EUDORI'NA. See Pandorina.

EUGLE'NA, Ehr.—A genus of Infusoria, of the family Astasiæa.

Char. Free; a red eye-speck, a tail-like process, and a single flagelliform filament; freshwater.

Many species, or rather forms, are distinguished by Ehrenberg and Dujardin. They are often present in vast numbers in pools, &c., rendering them green or red, and forming a brilliant pellicle upon the surface.

In the free condition the *Euglenæ* swim about in the water, not apparently by the help of the flagelliform filament, which seems to be often deficient, but by the contractile action of the whole body, the changes of form and movements of which may be roughly compared to those of a leech when crawling sluggishly over the surface of a glass. The *Euglenæ* present many points of resemblance to the lower Algæ, especially *Protococcus*, like them varying in colour from green to red, and, moreover, passing through a resting stage, encysted in a kind of cell-membrane, which is sometimes gelatinous, transparent, and spherical, sometimes rather horny, and polygonal in form. The encysted forms occur commonly aggregated together into indefinite frond-like masses; and the individuals multiply by division into two, four, &c., in this quiescent stage. The frond-like groups may be found in autumn, and even under the ice in winter, while the active forms abound most in spring, in fine weather. Carter has published some elaborate observations on the organization of these and allied forms, which we have not space to enter upon here. (See Astasiæa.) We can only notice two or three of the forms.

E. viridis (Pl. 31. fig. 2 *a*, *b*). Fusiform when extended; head narrowed, short; tail conical, short (not cleft); green, hyaline at the ends; length 1-1150 to 1-240″.

E. pyrum (Pl. 31. fig. 1). Body, when extended, oval, turgid, pyriform, obliquely furrowed, green; tail nearly as long as the body, acute; length 1-1150 to 1-860″.

E. longicauda, *Phacus longic.* D. (Pl. 31. figs. 3 & 63). Depressed, elliptical or oval, frequently twisted on its long axis, green, with longitudinal striæ; tail as long as the body, hyaline, subulate; length 1-280 1-120″.

E. acus (Pl. 31. fig. 4). Fusiform, slender, subulate, straight, green in the middle; head attenuate, somewhat truncate, hyaline; tail very acute, hyaline; length 1-570 to 1-216″.

Bibl. Ehrenb. *Infus.* 104; Dujardin, *Infus.* 358; Morren, *Rubéf. d. Eaux.* Brux. 1841; Carter, *Ann. N. Hist.* 1856, xviii. 115, and 1857, xx. 21; Kent, *Inf.* 379.

EUGLE'NIA, Duj. (Infusoria). See ASTASLÆA.

The essential character of this family is the presence of a contractile integument; this is probably of little importance, as in many cases the nature of the integument has been shown to depend upon season, locality, and stage of development.

EU'GLYPHA, Duj.—A genus of Rhizopoda.

Char. Free; single; carapace membranous, transparent, resisting, elongate-ovoid, urceolate, covered with rows of tubercles or depressions; orifice toothed; expansions numerous, simple.

This genus appears unnecessarily separated from *Difflugia*, E.

E. tuberculata (Pl. 30. fig. 53). Carapace covered with oblique or longitudinal rows of rounded tubercles. Freshwater; length 1-280''. Sometimes posterior spines are present.

E. alveolata (Pl. 30. fig. 54). Carapace covered with polygonal depressions, in regular oblique rows. Freshwater; length 1-280''. Posterior spines also present.

See DIFFLUGIA.

BIBL. Dujard. *Inf.* 251; Carter, *Ann. N. Hist.* 1865, xv. 290.

EUMERID'ION, Kütz. — Consolidated with MERIDION.

EUNO'TIA, Ehr.—A genus of Diatomaceæ.

Char. Frustules free, single or binate, quadrilateral; linear or linear-oblong in front view, curved or concavo-convex in side view; valves with terminal puncta (nodules?) and transverse or slightly radiating striæ, but no canaliculi. Freshwater and fossil. Allied to *Epithemia*.

Many of the species have undulations or ridges upon the convex surfaces; striæ resolvable into dots, but in some species difficult to detect; transverse section of frustule trapezoidal.

Kützing describes forty-four species; Smith admits seven as British.

E. tetraodon (*Himantidium tetr.*, K.) (Pl. 51. fig. 27: *a*, side view; *b*, front view). Frustules with four ridges; striæ distinct; length 1-570''.

E. monodon (*Himant. monodon*, K.). Side view lunate, no ridges, slightly constricted near the obtuse ends; striæ obscure; length 1-800''.

E. triodon. Ridges three; ends attenuate, rounded; striæ obscure; length 1-500''.

BIBL. Kützing, *Bacill.* 36, and *Sp. Alg.* 4; Smith, *Brit. Diat.* i. 15; Ralfs, *Ann. N. H.* 1844, xiii. 459.

EUNOTOGRAMMA, Weisse.—A genus of fossil Diatomaceæ.

Char. Front view as in *Anaulus*; side view lunate, with undulated dorsal and ventral margins.

E. tri-, quinque-, septem-, et novemloculata. Side view divided by 2, 4, 6, or 8 transverse septa into 3, 5, 7 or 9 loculi. Russia.

BIBL. Pritchard, *Infus.* 860; Weisse, *Bull. St. Pétersbourg*, xiii. 278.

EUODIA, Bailey.—A genus of Diatomaceæ.

Char. Frustules areolar or granular, side view lunate.

3 species: 2 fossil, 1 recent. Perhaps *Goniothecia*.

BIBL. Bailey, Pritchard's *Infus.* 852; Greville, *Micr. Trans.* 1861, 67.

EUPLEURIA, Arn.—A genus of Diatomaceæ.

3 species: New Zealand and Africa (Ichaboe guano).

BIBL. Arnott, *Qu. Mic. Jn.* 1858, vi. 89.

EUPLO'TA, Ehr.—A family of Infusoria.

Char. Body surrounded by a carapace; two distinct alimentary orifices, neither of which is terminal (=Oxytrichina with a carapace).

Locomotive organs consisting of cilia, hooks, claws, or styles. Dujardin states that the carapace undergoes diffluence like the substance of the body.

The genera are thus distinguished:—

Cilia, claws, or hooks present; no styles. { Mouth without teeth { Head distinct ...*Discocephalus*. / No distinct head..*Himantophorus*. / Mouth with teeth .....*Chlamidodon*. }

Cilia, claws, and styles present .....*Euplotes*.

Dujardin includes this family in his Plœsconina.

BIBL. Ehrenb. *Infus.* 374; Dujard. *Inf.* 429.

EUPLO'TES, Ehr. (*Plœsconia*, Duj., for the most part).—A genus of Infusoria, of the family Euplota, E.

Char. Furnished with cilia, styles, and hooks; teeth absent.

The species are very numerous.

E. patella, E. (*Plœsconia pat.*, D.) (Pl. 31. fig. 5: *a*, under view; *b*, side view). Carapace a testa, oval or suborbicular, slightly truncated in front, margins extending beyond the depressed body; dorsum raised or bossed with fine radiating striæ; cilia form-

ing a curvilinear series; freshwater; length 1-288 to 1-216″.

E. cimex, E. (*Cocoudina cimex*, D.).

E. charon, E. (*Pœsconia charon*, D.).

E. vannus, E. (*Pl. vannus*, D.) (Pl. 31. fig. 6).

E. monostylus, E. (*Ervilia legumen*, D.) (Pl. 30. fig. 52).

Bibl. Ehrenb. *Infus.* 377; Duj. *Infus.* 435; Stein, *Infus.* 158.

EUPODIS'CUS, Ehr.—A genus of Diatomaceæ.

Char. Frustules single, disk-shaped, circular, without internal septa; valves furnished with tubular or spiniform processes. Marine and fossil.

The processes are so easily broken off, that the apertures corresponding to the points of attachment are generally alone seen. The valves appear either distinctly areolar, the depressions being large; granular, from their being minute; or striated.

Two groups are recognizable:

a. Eupodiscus proper. Valves areolar or striated.

E. argus (Pl. 16. fig. 30: *a*, side view; *b*, front view). Valves slightly convex; processes three; diameter 1-156″.

E. sculptus, Sm. (Pl. 16. fig. 31). Valves striated, central striæ forming a quatrefoil; processes two; diameter 1-770 to 1-400″.

b. Aulacodiscus, E. Valves granular; processes very short, their bases connected with the centre of the valve by a furrow.

E. crux (Pl. 50. fig. 43). Diameter 1-380″.

E. Petersii. Processes four, with larger granules at their bases. Diameter 1-380″.

Bibl. Ehrenb. *Abh. Berl.* 1839; id. *Ber.* 1844, 73, 1845, 361; Smith, *Brit. Diat.* i. 24; Kützing, *Sp. Alg.* 134; Shadbolt, *Qu. Mic. Jn.* ii.; Roper, 1858, *ibid.* vi.; Greville, *Mic. Trans.* 1863, 73, (*Aulacodiscus*) 1864, pp. 9, 82, 87, 1865, p. 26, 1866, pp. 5, 80.

EUPO'DIUM.—A genus of Marattiaceous Ferns. Exotic.

EURO'TIUM, Lk.—A genus of Pyrenomycetes (Ascomycetous Fungi), on the distinct nature of which great doubt is thrown by the recent observations of De Bary. *E. herbariorum* of authors is a mildew, common upon decaying or preserved fruits, plants imperfectly dried for herbaria, &c., forming a whitish or yellow crust, composed of interwoven mycelium filaments, which are delicate when young, but become thickened and often coloured with age. Upon these are produced globular *conceptacles* or peridia, from 1-15 to 1-20‴ in diameter, composed of a distinctly cellular membrane, enclosing little sacs or *asci* containing several minute sporidia. According to De Bary, these conceptacles are produced upon the mycelium of *Aspergillus*, under certain unknown conditions; and the ordinary fructification of *Aspergillus* is only a basidiosporous form of the same plant which produces an ascophorous form in the *Eurotium* fruit. He states that he not only found them growing upon the continuations of the same branched mycelium filament, but that he has raised *Aspergillus*, which fruited, from the spores both of *Aspergillus* fruits and the sporidia of *Eurotium*; *Eurotium* could not be obtained from *Aspergillus* spores. The connexion between these forms is regarded as analogous to that between *Oidium* and *Erysiphe*. The fruit of *Eurotium* is a sexual product, and originates as follows. The ends of certain branches of the mycelium coil up like a cork-screw, becoming more closely approximated, until at length they come into contact, and form a cylindrical or conical mass, marked externally by the spiral lines of conjunction of the turns of the filament. From the base of this mass thin branches sprout, running up over it, one of them fusing with its apex, forming an antheridium or pollinodium, and producing fertilization. After fertilization, the young perithecia become segmented, the segments forming shoots, which branch, the terminations forming the asci or parent cells of the sporidia. The ripe *sporidia* often exhibit a curious form, like little cylinders with a concavo-convex cap applied over each: these appear to be the two halves of the dehiscent outer membrane (*exospore*); for in the germination of perfectly globular forms the mycelium filaments break through the outer tough coat, like a pollen-tube from the inner coat of a pollen-grain. The sporidia are about 1-350‴ in diameter, and of a light yellow colour in mass. The dimensions &c. of *Eurotium*, like those of *Aspergillus*, seem to vary with the external conditions.

Eurotium Rosarium, Greville (*Sc. Crypt. Fl.*) = *Sphærotheca pannosa*.

Bibl. Berk. in Hook. *Brit. Fl.* ii. pt. 2. 333; Greville, *Scot. Crypt. Fl.* pl. 164. fig. 1; Sowerby (*Farinaria*), pl. 379. fig. 3; De Bary, *Bot. Zeit.* xii. 425 (1854); Riess, *ibid.* xi. p. 134, and Fresenius, p. 474 (1853).

EURYCERCUS, Baird (*Lynceus*, in part, Müll.).—A genus of Entomostraca, of the order Cladocera, and family Lynceidæ.

Char. Subquadrangular (in side view); abdomen very broad, flattened, densely serrated; beak blunt, slightly curved downwards. Freshwater.

E. lamellatus (Pl. 20. fig. 39). Shell olive, ciliated on the anterior ventricose margin, arched behind; beak rather blunt and short; superior antennæ terminating in six short spines, each with a fine seta or bristle; anterior branch of inferior antennæ with five long filaments—one from the end of the first and second joints, three from the third, as also a small spine; posterior branch with three long filaments at the end of the last joint, the first and second each with a short spine only.

It generally lives at the bottom of the vessel in which it is kept.

Bibl. Baird, *Brit. Entom.* p. 123.

EUTER'PE, Claus.—A genus of Copepoda.

1 species: Ireland. (Brady, *Copepoda, Ray Soc.* ii. 22.)

EUTREP'TIA, Perty.—A genus of Flagellate Infusoria.

Char. Free, ovate, or pyriform, green; swimming or creeping; flagella two, equal; an anterior red eye-spot.

E. viridis. Length $\frac{1}{210}$". Pond-water.

Bibl. Perty, *Kl. Lebensf.* 168; Kent, *Inf.* 416.

EVADNE, Lovén.—A genus of Entomostraca, of the order Cladocera, and family Polyphemidæ.

Char. Abdomen short, scarcely projecting from the shell; head not distinct from the body; marine.

E. Nordmanni (Pl. 19. fig. 30). Colourless, excepting the eye.

Forms part of the food of the herring.

Bibl. Lovén, *Wiegmann's Archiv*, 1838, Bd. i. 143; M.-Edwards, *Crust.* iii. 390; Baird, *Brit. Entom.* 114.

EVER'NIA, Ach.—A genus of Lichenaceous Lichens, tribe Ramalinei; cosmopolitan in its range; recognized by its flattened, flaccid, laciniate, white or grey thallus, lateral apothecia, and simple spores. Two species: *E. furfuracea* (*E. Bot.* pl. 984) and *E. prunastri* (*E. Bot.* pls. 859 & 1353) occur in Great Britain.

Bibl. Nylander, *Syn.* 283; Leighton, *Lich. Fl. G. B.* 81.

EXCIP'ULA, Fr.—A genus of Sphæronemei (Stylosporous Fungi), forming horny tubercles on dead stems and leaves, finally opening by an entire orbicular aperture. The *stylospores* are elongated, lanceolate or fusiform; and long hair-like processes are sometimes mixed with the sporophores which line the disk. Four British species are recorded: *E. fusispora* and *E. strigosa* of Fries, and *E. macrosticha* and *E. chætostroma* of Berk. and Br. Perhaps related to some Ascomycetous form. (See Coniomycetes.)

Bibl. Berk. in Hook. *Br. Fl.* ii. pt. 2. 296; Berk. and Broome, *Ann. N. H.* 1850, v. 456, pl. 11. fig. 2.

EXID'IA, Fr.—A genus of Tremellini (Hymenomycetous Fungi), forming gelatinous, truncated black or coloured bodies on the trunks and branches of trees. Common in autumn and winter. Tulasne has lately published some interesting observations on the structure of the hymenium which clothes the upper face. This is composed of a densish layer of very slender filaments, which bear at their free surface globular cells (*basidia*) divided vertically into two or four chambers; from each of these arises a slender process (*sterigma*), at the end of which is developed a *stylospore*. In *E. spiculosa, spermatia* were also observed in young specimens, at the ends of very slender filaments passing through the mucilaginous layer overlying the layer of *basidia*. (See Dacrymyces, Hernkola, and other genera of Tremellini.)

Bibl. Berk. in Hook. *Br. Fl.* ii. pt. 2. 217; Tulasne, *Ann. Sc. Nat.* 3 sér. xix. 202, pls. 11 & 12.

EXOAS'CUS. See Ascomyces.

EXOBASID'IUM, Wor.—The lowest form of Hymenomycetes. *E. Vaccinii* is common on *Rhododendron* and *Vaccinium*, causing fleshy swellings on the leaves. It is *Ascomyces carnosa*, Berk.

Bibl. De Bary and Woronin, *Ber. Nat. Gesell. Freiburg*, ix. 397; Sachs, *Bot.* 336.

EXOCOC'CUS, Nägeli.—Probably a *Protococcus* or *Palmella*.

Bibl. Nägeli, *Neu. Algensyst.* p. 169.

EX'OGEN. See Dicotyledons.

EXOS'MOSE. See Endosmose.

EXPECTORATION.—The various objects which may be found in the expectoration are noticed under their respective heads, or those of the tissues from which they are derived; a list only need be given here.

Mucous corpuscles; epithelial cells, of the pavement, cylinder, or ciliated forms; exudation globules, or granule-cells; pus and pyoid corpuscles; coloured corpuscles of the blood; pseudo-membranous flakes of fibrine; tubercle; fatty matter in the form of glo-

bules, rarely of crystals; earthy matters, amorphous or crystalline; various substances derived from the food, as muscular fibre, starch-granules, cellular tissue, &c.; entozoa, or fragments of them, as portions of the cysts or hooks of *Echinococcus*; infusoria and algæ, as Monads, *Bacteria*, *Sarcina*, &c.; carbon and true pigment, either in the free state or contained within epithelial cells; and fragments of pulmonary tissue.

The aid of the microscope in the examination of the expectoration will occasionally throw an unexpected light upon the diagnosis of disease. And it has been shown, that by boiling the sputa with solution of caustic soda and washing, the pulmonary fibrous tissue may often be detected in Phthisis.

EXUDATION, and EXUDATION CORPUSCLES. See INFLAMMATION.

EXU'VIUM (exuvia; or exuviæ, plur.).—The cast or shed skin of animals. The exuvium of many minute animals exhibits the form and structure of the skin, and the parts upon which it is moulded, better than these can be discerned in the living animals, on account of its transparence. The exuvium of the TRITON (Pl. 49. fig. 12) exhibits the cellular structure of the epidermis very beautifully.

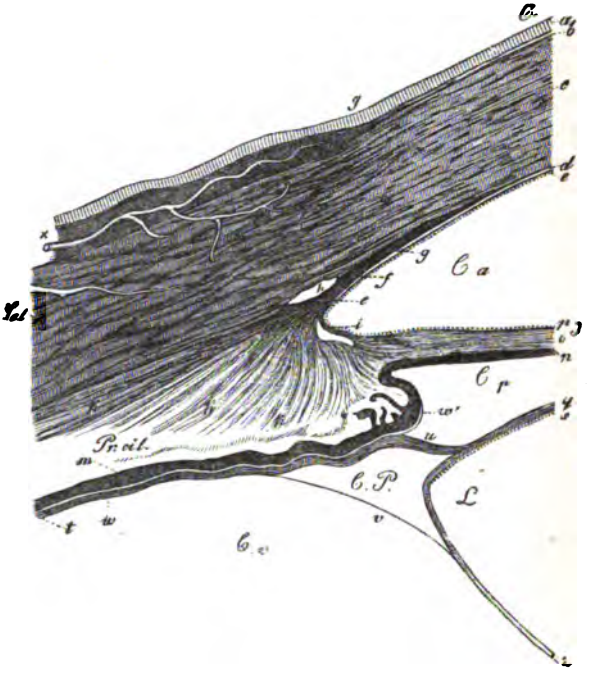
EYE.—From want of space, we are compelled to assume that the reader possesses a knowledge of the component parts of the eye and their relative position, as far as can be obtained without the use of magnifying glasses. These parts are generally described in works upon anatomy, and in most of those upon optics.

The outer fibrous coat of the eye is commonly regarded as consisting of two parts: one anterior, smaller and transparent—the cornea; the other, posterior larger and opaque—the sclerotica. The history of the development and the minute structure of these prove that they must be considered as forming a single continuous membrane.

The *cornea* may be regarded as consisting of three layers:—1, the corneal conjunctiva; 2, the true cornea; and 3, the membrane of the aqueous humour.

The *corneal conjunctiva* (fig. 207, *C a*) consists of laminated soft epithelium—the

Fig. 207.



Section of the membranes of the eye, near the ciliary processes.

Scl., sclerotica; *C*, cornea; *Pr. cil.*, ciliary process; *C a*, anterior chamber; *C p*, posterior chamber; *Cv*, vitreous humour; *C. P.*, canal of Petit; *L*, lens; *I*, iris: *a*, conjunctiva of the cornea—epithelial layer; *b*, subjacent elastic layer; *c*, fibrous layer of the cornea; *d*, membrane of the aqueous humour; *e*, its epithelium; *f*, end of the membrane and its fusion with the fibres *g*, which pass to the iris at *i*, forming the pectinate ligament; *h*, venous canal; *k*, ciliary muscle arising from the inner wall *l* of the venous canal; *m*, pigment-layer of ciliary processes; *n*, that of iris; *o*, fibrous layer of iris; *p*, its epithelium; *q*, anterior wall of capsule of lens; *s*, epithelium of capsule; *t*, anterior thickened portion of hyaloid membrane; *u*, zonule of Zinn, or anterior lamina of hyaloid membrane; *v*, posterior lamina of the same; *w*, colourless epithelium of the ciliary processes; *w'*, anterior end of this epithelium; *x*, conjunctiva of sclerotica; *z*, posterior wall of the capsule of the lens.

Magnified 12 diameters.

under layer of cells elongated and placed perpendicularly to the surface, the middle cells rounded, those in the upper layer forming softer nucleated plates. Many of the latter are furnished with larger or smaller depressions, arising from mutual pressure, so as to appear stellate in the side view. Beneath the epithelium is a structureless layer (*b*), the anterior elastic or Bowman's membrane, consisting of the remains of the formerly vascular layer of the corneal conjunctiva.

The *true cornea* (fig. 207 *c*), which forms the principal part of the membrane, consists of a substance nearly allied to connective tissue. Its elements are pale bundles from 1-6000 to 1-3000″ in diameter, with still finer fibrillæ, united to form larger lamellar bundles, the surfaces of which are parallel to that of the cornea; these are connected with the bundles before and behind, so as to form a coarse reticular tissue. Between the bundles are a large number of anastomosing, fusiform, and stellate lacunæ, within which are contained cell-structures forming the corneal corpuscles. The cells undergo fatty degeneration, partly forming the *arcus senilis*; and they sometimes contain pigment.

The cornea contains numerous fine nerves, which ramify nearly to the surface, between the epithelial cells.

The *sclerotica* (fig. 207, *Scl.*) or *tunica albuginea* covers the posterior four fifths of the ball of the eye; it is a milk-white, very firm, fibrous membrane, continuous posteriorly with the sheath of the optic nerve, becoming gradually thinner in front, except at its termination, where the tendons of the recti muscles become fused with it. It consists of connective tissue, the bundles of which are mostly straight, intimately united as in the tendons, forming alternating longitudinal and transverse layers of various breadth and thickness. Mingled with the connective tissue are numerous fine elastic fibres, in the form of a network, with thickenings which indicate the remains of the nuclei of the formative cells; these, in the inner portions, contain pigment. During life, the elements of this network, in parts, appear to involve canals with liquid contents; so that, when dried, they contain air.

The *membrane of the aqueous humour* (fig. 207 *d*) consists of an elastic, perfectly structureless (Descemet's) membrane, somewhat loosely connected with the cornea, and an inner epithelial lining. Towards the circumference of the cornea, the membrane of the aqueous humour merges into a peculiar system of fibres, which commence near the margin of the cornea, at the anterior surface of the aqueous membrane (fig. 207 *g*) as an extended network of fine fibres, resembling elastic fibrillæ; this increases in thickness, and at the very margin of the cornea the aqueous membrane becomes lost in a tolerably dense network of these fibres, which curve around the margin of the iris (fig. 207 *i*), some passing through the anterior chamber, and become fused with the anterior surface of this membrane and the ciliary ligament (or muscle). These fibres form the *pectinate ligament* of the iris, which is much more distinct in some animals (as the dog) than in man.

The epithelium (*e*) of the aqueous membrane consists of a single layer of polygonal cells. These become smaller near the margin of the cornea, where the membrane terminates as a continuous layer; but isolated portions of elongated or spindle-shaped cells are continued over the pectinate ligament to the anterior surface of the iris.

The cornea yields chondrine on boiling, and not gelatine.

The *choroid membrane* contains a large number of blood-vessels, and abounds in pigment. Its anterior, smaller, and transverse portion *I* forms the iris.

The posterior portion, or proper choroid membrane, is from 1-360 to 1-180″ in thickness, and extends from the entrance of the optic nerve to near the anterior margin of the sclerotica, where it becomes thicker, forming the ciliary body, whence it is continued into the iris.

The choroid consists essentially of two parts:—an outer vascular and thicker layer, the proper choroid; and an inner deeply coloured layer, the *pigmentum nigrum*. The former may again be separated into three parts, although these are not really distinct:—1, an outer, brown, soft layer, which supports the ciliary nerves and long ciliary vessels, and contains anteriorly the ciliary ligament—the outer pigment layer; 2, a less highly coloured proper vascular layer, with the larger arteries and veins; and 3, a colourless delicate inner layer, containing an extremely copious capillary network—the choro-capillary membrane, which does not extend anteriorly beyond the margin of the retina. The stroma of the choroid proper consists of very irregular spindle-shaped or stellate cells, from 1-1500 to 1-6000″ in length, either paler, or con-

taining a large quantity of pigment, and anastomosing by numerous long and very slender processes (fig. 208). These cells are most distinct in the outer layer; whilst more internally, and especially in the choro-capillary membrane, they gradually pass into a homogeneous or slightly striated nucleated tissue, containing but little and ultimately no pigment.

Fig. 208.

Cells from the stroma of the choroid; *a*, containing pigment; *b*, fusiform cells without pigment; *c*, anastomosis of the former. Magn. 350 diams.

In some animals the choroid membrane contains muscular fibres.

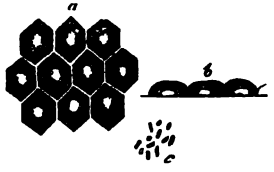
Between the stroma and the pigmentum nigrum is a very thin elastic layer; this is either structureless, granular, or finely reticulated, and is comparable to a basement membrane.

The *ciliary* muscle—*tensor choroideæ* (fig. 207 *k*)—is composed of a tolerably thick layer of radiating unstriated muscular fibres; these, intermixed with pigment-cells of the choroid, pass from the anterior margin of the sclerotica to the ciliary body, and lose themselves in its anterior half, opposite the base of the ciliary processes. The fibre-cells are 1-600″ in length, broader than most fibre-cells, and not easily isolated in man.

The *ciliary processes* consist of the same stroma as the choroid; but the stellate cells are more delicate and fewer, and, with the exception of those at their base, do not contain pigment; nor are they furnished with the elastic lamina.

The *pigmentum nigrum* (fig. 207 *m*) lines the inner surface of the choroid, and as far

Fig. 209.



Cells of the human pigmentum nigrum *a*, surface view; *b*, side view; *c*, pigment-granules. Magnified 350 diameters.

as the termination of the retina, consists of a single layer of beautiful, regularly six-sided cells (fig. 209 *a*, *b*), from 1-2000 to 1-1500″ in diameter; they contain abundance of pigment. Beyond the margin of the retina, the cells form mostly two layers, and become rounded and more loaded with pigment. The granules of pigment are very minute, rounded, from 1-20,000 to 1-30,000″ in diameter, and exhibit molecular motion. In the eyes of albinos, and in the region of the tapetum of animals, the cells contain no pigment.

The *iris* (fig. 207, *I*) consists of three layers:—an anterior epithelial layer; a posterior layer of pigment, called the *uvea*, and continued from the inner pigment layer of the choroid; and a middle, the thickest or fibrous layer.

The fibrous layer differs from the choroid, in containing connective tissue forming delicate loose bundles, some of which pursue a radiating, others a circular course, and interlacing variously; in this tissue are a number of spindle-shaped or stellate cells, containing pigment, corresponding to those of the choroid, and in addition to numerous blood-vessels and nerves, two sets of muscular fibres: the latter in some animals are transversely striated; but in man they resemble the ordinary unstriped fibre-cells, and are 1-600 to 1-400″ in length. One set forms a sphincter for closing the pupil, its fibres taking a circular direction; the other set consists of bundles of radiating fibre-cells, traversing the stroma of the iris. The pigment layer or *uvea* consists of the same elements as those of the corresponding layer of the choroid.

The anterior coat consists of a single layer of rounded, flattened epithelial cells.

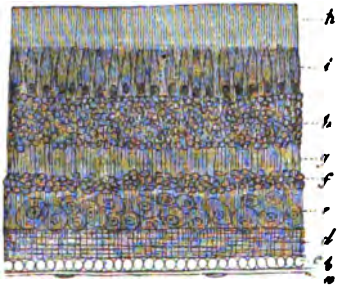
The blood-vessels of the choroid membrane and ciliary processes are easily injected (*e. g.* in the sheep or ox) from the ciliary arteries, and form a magnificent object.

The retina is the terminal membranous expansion of the optic nerve within the globe of the eye. It consists of nerve-cells and fibres, imbedded in a spongy supporting connective tissue.

Nine layers are distinguishable in a transverse section of the retina (fig. 210), commencing from within: viz. 1, the internal limiting membrane (*b*); 2, the layer of optic nerve-fibres (*d*); 3, a layer of nerve-or ganglion-cells (*e*); 4, a molecular layer; 5, an inner granular layer (*f*); 6, an intermediate granular layer (*g*); 7, an outer

granular layer (*h*); 8, a narrow outer limiting membrane; and 9, the layer of cones (*i*), and bacilli (*k*). The pigment-cells of the choroid membrane are also sometimes considered a layer of the retina.

Fig. 210.



Perpendicular section of a piece of the posterior part of the human retina.

a, hyaloid membrane with nuclei; *b*, internal limiting membrane; *c*, ends of the radiating fibres, so altered as to present a cellular appearance; *d*, layer of optic nerve-fibres; *e*, layer of nerve-cells; *f*, inner granular layer; *g*, intermediate or finely granular layer, in which the radiating fibres are more distinct than elsewhere; *h*, outer granular layer; *i*, inner division of the layer of bacilli, with the cones; *k*, outer division, with the processes of the cones and the true bacilli.

Magnified 350 diameters.

The internal limiting membrane (*b*) is an extremely delicate structureless film, covering the inner surface of the retina, including the entrance of the optic nerve, and the macula lutea.

The expansion of the optic nerve forms a membranous layer of extremely delicate transversely radiating fibrils (fig. 211, 3), from 1-24,000 to 1-12,000″ in diameter, and mostly exhibiting varicosities. They contain no nuclei, and appear to consist of the axial fibres only. They are aggregated into flattened bundles which either run parallel or anastomose with each other. They are absent, or at least as a coherent layer, opposite the macula lutea.

The layer of nerve-cells (*e*) consists of ordinary nerve-cells, pyriform, roundish, or angular, with pale processes; they vary in diameter from 1-3000 to 1-750″.

The molecular layer lies between the ganglion-cell layer (*e*) and the inner granular layer (*f*). The outer limiting membrane is situated between the outer granular layer (*h*) and the layer of cones and bacilli (*i*).

The remainder of the retina is mainly composed of a very large number of parallel, very slender (1-60,000 to 1-20,000″ diameter), highly refractive, radiating fibres or tubes (Müller's fibres), with their axes at right angles to the surface of the choroid, upon which their outer ends rest, whilst their inner, triangular or branched extremities are in contact with the limiting membrane. They produce the striated appearance presented by a section of the retina (fig. 210). They are furnished at certain parts of their course with expansions containing each a nucleus; and the fibres are very numerous. These nucleated expansions being opposite each other, or in the same planes, give rise to the appearance of distinct granular layers mentioned above. The more internal nucleated expansions are

Fig. 211.

Elements of the human retina. 1. Radial fibres with bacilli: *k*, bacillus, connected with the fibre (*r*) by its inner acute end; *h*, nucleated expansion (cell), appearing in the outer granular layer; *l*, expanded end of the fibre, resting upon the limiting membrane *m*; *k'*, a bacillus connected with a cone *i*; *r'*, fibre running from the cone to the cell *f* of the inner granular layer; *n*, branched termination of a radial fibre, often present. 2. Bacilli separated from the fibres, broken and curved, &c. 3. Fibrils from the expansion of the human optic nerve: *a a*, larger, *b*, smaller, fibrils with varicosities; *c*, undulating pale fibres belonging probably to the proper radiating system. 4. Two cones connected with bacilli, and fragments of the fibres remaining: *a*, bacillus; *b*, cone; *c*, nucleus of cone.

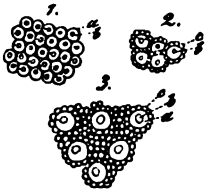
Magnified 350 diameters.

connected with the nerve-cells of the retina by minute nerve-tubes.

Their outer portions have been distinguished as the *bacilli* and *cones*; but the whole probably form one continuous system of nerve-cells and tubes.

The *bacilli*, regarded (fig. 211, *1 k k', 2*) as distinct bodies, are cylindrical, narrow and elongated, of the same breadth throughout, truncated externally, and terminating internally in a more slender portion of the fibre; they are from 1-430 to 1-330″ in length and 1-15,000″ in breadth; near the point of attachment to the fibre is a transverse line. They are extremely delicate, and easily broken or deformed. The cones (fig. 211 *1 i, 4 b*) are bacilli with a conical or pyriform body, and are also very easily injured. A slight constriction divides each cone into two parts, the innermost of which (fig. 211 *4 c*) contains a nucleus. The cones are from 1-6000 to 1-4000″ in diameter. In most parts of the retina the cones are surrounded by several bacilli; opposite the macula lutea they alone form a continuous layer; whilst at its margins, single bacilli intervene between the cones (fig. 212).

Fig. 212.



End view of the rows of bacilli and cones from the outside. 1, opposite the macula lutea, cones only; 2, at its margins; 3, at the middle of the retina. *a*, cones or spaces corresponding to them; *b*, bacilli of the cones, the ends of which are often situated somewhat beneath the level of those of the true bacilli, *a*.

Magnified 350 diameters.

Opposite the entrance of the optic nerve, both bacilli and cones are absent. These curious bodies are more distinctly seen in many animals than in man (Pl. 50. fig. 5), and they present certain varieties: thus, the cones are deficient in bats, the hedgehog, the mouse, the mole, and the sharks and rays; while the bacilli are deficient in the reptiles.

The inner ends of the radiating fibres when overlapping each other, and especially when swollen by the action of water, present the appearance of a number of rounded or angular cells (fig. 210, *c*), for which they were once mistaken.

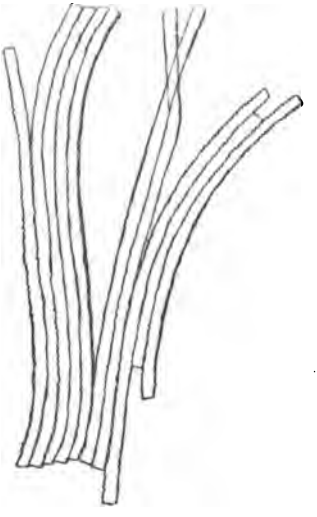
It is thus evident that, excepting the layer of nerve-cells and that of the fibres of the optic nerves, the retina cannot truly be considered as composed of layers. The series of bacilli and cones, when torn from their connexion with the radial fibres, form the so-called *Jacob's membrane*.

Between the nerve-fibres, from the outer to the inner limiting membrane, lies the connective supporting tissue; this also forms a considerable portion of the molecular and granular layers. In modern works, the fibres of this tissue are called Müller's fibres. But Kölliker has shown that the true radiating or Müller's fibres are not dissolved by boiling, and are coloured red by Schultze's test; so that they have not the chemical composition of connective tissue.

We cannot enter into the physiology of these radial fibres, which have been shown to be the percipients of light.

Crystalline lens. The crystalline lens is contained in a capsule (fig. 207 *q s*), consisting of a perfectly structureless, very elastic membrane, the anterior half of which is lined with a single layer of very

Fig. 213.



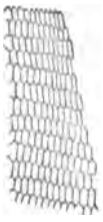
Fibres or tubes of the lens of the ox.

Magnified 350 diameters.

transparent, polygonal, epithelial cells (fig. 207, *s*), from 1-2000 to 1-1200″ in diameter.

The lens itself consists of long, transparent, six-sided, flattened fibres (fig. 213), from 1-4800 to 1-2400″ in breadth and 1-8500 to 1-13,000″ in thickness; these are tubular, at least in the outer portions of the lens, and contain a tenacious sarcodic substance, which escapes from the ends of the broken fibres in irregular globules. The form of the fibres is best seen in a transverse section (fig. 214).

Fig. 214.



Transverse section of the fibres or tubes of the human lens.

Magnified 350 diameters.

The fibres are firmer, narrower, and more highly refractive towards the centre of the lens. Their general arrangement is such that their broad surfaces are parallel with the surface of the lens, and that they follow a direction from the middle of the anterior to that of the posterior surface, curving laterally in their course—not, however, exactly from the middle, but from the arms of a star-shaped kind of centre, at which parts (fig. 215) the fibres are

Fig. 215.

Anterior view of human crystalline lens (adult), showing the stars and the direction of the fibres.

Magnified 5 diameters.

replaced by a homogeneous or finely granular matter. The arms of the star present upon the surfaces are the extremities of planes extending through the substance of the lens, from which the inner fibres take their origin. The arms of the anterior and posterior stars are not parallel with each other; nor are the fibres arising from any part of the arm of one cross inserted into the corresponding part of the arm of the opposite cross. Great variety exists in different animals in the structure and arrangement of these stars and planes. Thus in the human fœtus the star has three arms or planes, whilst in the adult there are from nine to sixteen, of which three are frequently more distinct than the others. In some animals they are replaced by a pole, from which the fibres radiate like meridians, as in the cod, the *Triton*, and *Salamandra*; in others, there is a single plane, as in some fishes, the frog, the hare, the rabbit, and the dolphin; whilst in most of the mammalia there are three, and in the whale, the bear and the elephant there are four.

The edges and marginal surfaces of the fibres of the lens are uneven or toothed, so that their lateral connexion becomes more intimate; hence the lens separates more readily into parallel laminæ in the direction of the surface than in the opposite direction.

In many animals, especially fishes, as the cod, the roach, &c., the irregularities of the fibres of the lens are replaced by beautiful teeth (Pl. 50. fig. 6).

Vitreous humour, or body, is enclosed in a membrane, the *hyaloid membrane*, which behind the dentate margin of the retina is extremely thin and delicate; anterior to this it becomes firmer (fig. 207 *t*) and passes, forming the *zonule of Zinn*, to fuse with the capsule of the lens. In thus doing, it separates into two layers:—a posterior (*v*), which becomes consolidated with the capsule of the lens somewhat behind its margin; and an anterior (*u*), connected with the ciliary processes, which becomes attached to the capsule of the lens, a little in front of its circumference: between these two is the *canal of Petit* (*C. P.*). The posterior layer is sometimes considered as arising from a condensation of the tissue of the vitreous humour. The structure of the vitreous body is still obscure.

The structure of the eye is very difficult of examination, the parts being so delicate and easily injured. Many of them can be

made out by dissecting the eye under water; but the more delicate structures should be immersed in the liquid of the anterior chamber. Solution of chromic acid and alcohol is useful for hardening the parts to allow of sections being made with a Valentin's knife. The cornea may be hardened in chromic acid, sections cut in paraffine, and stained with logwood. The nerves and corpuscles are best stained with nitrate of silver or chloride of gold. The retina may be hardened in chromic acid and spirit, and the rods and cones in osmic acid, sections being made by freezing; logwood stains the granular layers, the rods and cones remaining unaltered. The lens should be hardened, either by maceration in solution of chromic acid, or by drying. The fibres may be well preserved in the dry state.

The structure of the eyes of the lower animals is briefly noticed under the classes, &c. In the mammalia generally, it is essentially the same as in man; and the eye of the ox or sheep may be selected for examination.

Bibl. Kölliker, *Mik. An.*; Todd and Bowman's *Phys. of Man*; Müller, H., *Comptes Rendus*, 1856, 743 (*Ann, N. H.* 1856, xviii. 492); Nunneley, *Qu. Micr. Jn.* 1858, 136; Schultze, *An. und Phys. d. Retina* (8 pl.), 1867, & Stricker's *Handbuch*, 976; Hulke, *Mn. Mic. Jn.* ii. 227, *Phil. Tr.* cv. 109; Lawson, *Ciliary Muscle of Birds, ibid.* ii. 204; Frey, *Histol.*, 1876, and the full literature therein; Klein, *Histol.* 342; Hannover, *Rét. de l'homme et d. Vértébr.*, 1877; Gerlach, *An. mensch. Auge*, 1880; Eloni, *Cornée d. an. vert.* 1881.

EYLAÏS, Latr.—A genus of Arachnida, of the order Acarina, and family Hydrachnea.

Char. Palpi longish, fourth joint longest, the fifth obtuse, somewhat tumid, spinous; mandibles unguiculate; rostrum very short, mouth round; body depressed; two approximate pairs of eyes; coxæ comparatively narrow, the fourth only in contact with the third at its base.

E. extendens (Pl. 6. fig. 28). Skin soft, furrowed, with the ramified alimentary canal visible through its substance. Between the two anterior coxæ (*d*) is seen the bilobed labium (*a*), the posterior portion containing the round and ciliated mouth, the anterior portion forming a kind of hood; palpi (*b*) with the three first joints very short; mandible consisting of a long thick joint, with a thick mobile claw (*c*). Fig. 28 *d*, under surface of body, exhibiting from before backwards:—the mouth, with the hood, and the palpi; next two groups of anterior coxæ; the vulva and two stigmata; the four posterior coxæ; and, lastly, the anus in the middle, with a stigma on each side.

The larvæ are hexapod, reddish, pellucid, with the eyes four, wide apart.

E. confinis, K.

E. atomaria, K.

Bibl. Dugès, *Ann. Sc. Nat.* 2 sér. i. 156; Gervais, *Walcken. Arachnid.* iii. 207; Koch, *Deutschl. Crustac.*

F.

FABULARIA, Defrance.—A porcellaneous Foraminifer, growing like a *Biloculina*, but having its chambers filled with labyrinthic shell-matter, the cavities in which are mostly elongate with the axis of the shell. They are narrow, and, opening terminally, make a cribriform septal face.

Quinqueloculina saxorum has thickenings within, making internal grooves and ridges, thus verging on the Fabularian type; and *Hauerina* has a cribriform septal plate, but without superadded internal structure.

Fabularia ovata (De Roissy), known also as *F. discolithus* of Defrance, abundant in the Eocene Tertiaries of France, is the only known species.

Bibl. Carpenter, *Introd. Foram.* 82.

FADYE'NIA, Hook.—A genus of Aspidieæ (Polypodiaceous Ferns); 1 spec., Brazil.

FÆCES.—We shall not dwell upon the nature of the objects contained in the fæces; suffice it to say that they may consist of:—the elements of the various secretions poured into the intestinal canal; the products of inflammation; undigested remains of articles of food, or bodies taken with the food or drink; and entozoa (*Anchylostoma, Anguillula, Trichocephalus*), *Amœbæ, Bacteria* &c. Some of these resemble other bodies very closely to the naked eye. The use of chemical reagents should never be omitted in their examination.

FARREL'LA, Ehr.—A genus of Ctenostomatous Polyzoa, fam. Vesicularidæ.

F. repens; no gizzard; on shells, algæ &c. (Hincks, *Polyzoa*, 528.)

FASCIÆ.—The fasciæ consist of the same elements as Areolar Tissue, and

present all the varieties of arrangement intermediate between it and TENDON.

FATTY DEGENERATION. See DEGENERATION, FATTY.

FATTY TISSUE, or ADIPOSE TISSUE.—This is formed of colourless cells, with a very delicate, transparent, structureless cell-wall, enclosing, in the normal state, globules of yellowish fat (Pl. 49. fig. 41). The cells generally occur in groups, surrounded by or imbedded in connective tissue. They are rounded when isolated, or polygonal when aggregated, and from 1-800 to 1-300″ in diameter; and the fat so fills them, that neither the nucleus which they contain nor the cell-wall is visible. The fat may be removed by drying them, and digesting with ether, when the cells appear contracted and wrinkled. In emaciated and dropsical subjects, each cell contains a number of small globules of fat, frequently of a reddish colour (Pl. 38. fig. 3), together with serum, and the nucleus is very distinct. Sometimes in these cases the cells are somewhat spindle-shaped or stellate. The fat contained in the cells is ordinarily in a liquid state; but sometimes the margarine separates in the crystalline form (Pl. 11. fig. 15 *a*).

In the mammalia generally the fatty tissue occurs in the same localities, and has the same structure, as in man. In fishes, the fatty matter is deposited principally in the liver. In reptiles, it occurs chiefly in the abdomen: thus in the frog and toad it forms long appendages occupying the sides of the spine. In birds, it exists chiefly between the peritoneum and the abdominal muscles, and in some of the bones. In many of the lower animals it appears to exist in the state of solution only.

Fatty tissue is formed from connective-tissue cells.

Fatty matter may be deposited in cells of all kinds, as in FATTY DEGENERATION. During the development of cells, it exists in solution. The action of solution of potash is often of service in distinguishing globules of protoplasm, which have a high refractive power, and much resemble those of fat, from this substance, as it dissolves the former, but not the latter; solution of osmic acid renders fat-globules black.

BIBL. Todd and Bowman, *Phys. of Man*; Kölliker, *Mikr. An.*; Klein, *Hist.* 42; Frey, *Hist.*

FAUJASINA, D'Orb.—A delicate and handsome Foraminifer, but not typical.

F. carinata, D'Orb., found in the Maestricht Chalk, is a thin asymmetrical (planoconvex) *Polystomella*, somewhat thinner or flatter than *P. macella* (F. & M.), which is a subcomplanate, perhaps starved, variety of *P. crispa* (Linn.).

BIBL. Parker and Jones, *Ann. N. H.* 3 ser. v. 104; Carpenter, *Introd.* 213, 286.

FAVEL'LA.—A form of the conceptacular fruit of the Florideous Algæ, where the spores are collected in spherical masses situated wholly upon the external surface of the frond, as in *Ceramium* and *Callithamnion*.

FAVELLID'IUM.—A form of the conceptacular fruit of the Florideous Algæ, where the spores are collected in spherical masses attached to the wall of the frond or imbedded in its substance, as in *Halymenia* and *Dumontia*. The term is usually extended to similar fruits not perfectly immersed, *e. g.* those of *Gigartina*, *Gelidium*, &c., where they form tubercles upon the branches. Sometimes these tubercles open by a pore on the surface, when mature, to emit the spores.

FA'VUS (Porrigo in part, Willan and Bateman).—A disease of the skin, characterized by the presence of cup-shaped isolated or aggregated crusts, consisting of a Fungus. (See ACHORION.)

FEATHERS OF BIRDS.—Feathers agree in all essential points of structure with the hairs of other animals.

Each feather is composed of a quill (containing the pith), a shaft, and a vane or beard with its barbs. The whole consists of a number of epidermic cells, often containing pigment, but in most parts so consolidated or fused together as to be imperceptible.

In the quill, the cells are flattened, elongated, and arranged with their long axis in the direction of that of the feather, and their nuclei have the same form as those of the corresponding part (cortex) of the human hair. The cells of the pith are often undistinguishable in old feathers, whilst in the younger ones they are very distinct, rounded or polygonal, and contain air. The shaft and the barbs exhibit the same cortical and medullary structure; the latter is often beautifully distinct (Pl. 22. figs. 14 & 15 *c*), and causes them to resemble closely the hairs of some Rodents. The barbs are sometimes furnished with secondary barbs, or barbules, resembling them in form, but differing mostly in the absence of the pith.

Feathers are developed in a capsule, and from a pulp or matrix, as in the case of

hairs. Hence a feather may be regarded simply as a large, doubly or triply pinnate hair.

During development, the cell structure is very distinct; but in the mature feathers, digestion with solution of caustic potash is requisite to render this visible; and frequently even under these circumstances, the nuclei alone can be detected.

The barbs of some feathers resemble the shafts, being rounded or angular, and free or unattached (figs. 17 & 18); but in others they are flattened, and linked together in a remarkable manner, much resembling that met with in the wings of Hymenopterous and other Insects (Pl. 34. figs. 11 & 13), and which has been so often adduced as one of the many wonderful instances of design in the creation. Thus the upper or outer margin of each barb is fringed on both sides with hair-like elongated processes or pinnæ (Pl. 22. fig. 15 *a*, *b*), which differ in structure on the two sides. On one, and this always the same side of each barb (fig. 15 *b*), the pinnæ are toothed on one edge (fig. 16 *b**), whilst the pinnæ arising from the other side (fig. 15 *c*) exhibit, beyond the middle, a number of curved hooks (fig. 16 *a*), which clasp around the first kind existing upon the adjacent barb, so as to retain a firm hold upon them, this being aided by the teeth, which prevent them from slipping. If the relative position of the two sets of pinnæ which spring from two adjacent barbs be examined, it will be seen that they cross each other at a considerable angle, so that any pinna from one barb crosses several of those belonging to the next barb. Hence each pinna is connected by its hooks with several of those which it crosses; for the pinnæ with hooks are situated outside or above those not furnished with these appendages. The under or inner margin of each barb is simply membranous, and curved so as to overlap that of the next.

The free barbs of feathers are often met with in the examination of liquids &c. left exposed to the air (figs. 17 & 18).

Bibl. Schwann, *Mik. Untersuch.*; Reclam, *De Plumar. Evolut.*; Leydig, *Histol.* 99; R. Beck, *Achr. Micr.* 31.

FEET.—In descriptions, &c., of the Articulata, especially of Insects, the word *feet* is mostly used to designate the legs; hence when met with in the works of systematic and other writers on these classes, it must be understood to mean the legs.

FEET OF INSECTS. See INSECTS, *Legs*.

FEGATEL'LA, Raddi (*Conocephalus*, Hill).—A genus of Marchantiaceous Hepaticæ. *F. conica* (*Marchantia conica*, Brit. Fl.), the only British species, is not uncommon, and is one of the largest of the tribe. It is distinguished from *Marchantia* by its nearly entire conical fertile receptacle. The dichotomously divided frond is of a yellowish green colour. This genus is remarkable for the mode in which the pedicel of the sporange becomes detached from the base of the epigone before the former bursts (fig. 220); the perigone holds the sporange firmly between its valves until empty, and then lets it fall out, together with its pedicel. Hence fully-developed sporanges are seldom found in dried specimens. (See MARCHANTIEÆ.)

Fig. 219.

Fig. 220.

Fegatella conica.

Fig. 219. Vertical section of the upper part of a fertile receptacle, showing four of the sporanges surrounded by their perigones and epigones almost enclosed in the conical receptacle. Magnified 10 diams.

Fig. 220. A sporange just before bursting, enclosed in its epigone; its pedicel detached at the base. Magn. 20 diams.

Bibl. Hooker, *Brit. Fl.* v. pt. 1. 107; Bischoff, *Nova Acta*, xvii. 970, pl. 68; *Engl. Bot.* pl. 504.

FEL'SPAR. See ROCKS.

FEL'STONE. See ROCKS.

FENESTRELLA, Grev.—A genus of Diatomaceæ.

Char. Frustules free, disciform; disk with minute radiant dots, interrupted in the middle by a transverse band, composed of parallel lines of dots, band terminated at each end by a flat ocellus (nodule).

F. barbadensis. Barbadoes deposit.

Bibl. Greville, *Micr. Tr.* 1863, p. 67.

FERMENTATION.—Under this name are understood various processes of decomposition of organic compounds; although it would be desirable to restrict it to those taking place with the cooperation of living organisms. The most familiar examples of the fermentation produced by the growth

of living organisms, are those which convert saccharine infusions into spirit, vegetable juices into beer, wine, &c., or vinegar; and occur generally in watery solutions of vegetable substances containing saccharine matters or other ternary compounds with a certain amount of nitrogen; with these is included also the putrefactive fermentation of moist animal or other highly nitrogenous substances.

Much obscurity still prevails upon this subject; but all investigations appear to tend in the direction of proving that these changes are absolutely dependent upon the agency of Fungi; and that each kind of fermentation is produced by a distinct vegetable organism. Thus: the vinous fermentation appears to depend entirely upon the growth of Yeast, a microscopic fungus, in the liquid (see YEAST); while milk-fermentation is caused by *Bacterium lineola*; butyric fermentation by *Bacillus subtilis* &c. Yet, according to the experiments of Muntz and Pasteur, it appears that the living cells of the higher plants, can in the absence of oxygen, act like fungi, and produce a true introcellular alcoholic fermentation. The Yeast-plant as ordinarily known, appears so associated with *Penicillium*, that there seems no doubt as to the necessary relation between them. We find that beer, exposed to the air at ordinary summer temperatures, soon becomes coated with the minuter globules (conidia) of Yeast, forming a dry-looking whitish powder over the surface; and very soon after, *Penicillium glaucum* makes its appearance in fruit. Turpin found the same thing in milk. Again, the 'vinegar-plant,' as it is called, which converts solutions of sugar into vinegar, seems to be undoubtedly the mycelium of *Penicillium glaucum*, as it fructifies with the characters of this when the liquid is exhausted; but the gelatinous mass of mycelium contains, intermixed with the ordinary filaments of this genus, spherical and elliptical cells and chains of cells of all sizes, many of which are undistinguishable from the Yeast-plant, and the mycelium of *Oidium*. It must be recollected also, that the growth of true Yeast is favoured by a certain amount of heat, while the *Penicillium*-mycelium grows luxuriantly at ordinary temperatures. Dead Yeast causes no fermentation.

The 'mother' of vinegar, which finally decomposes the acid, appears to be the same plant; and no satisfactory distinction can be drawn between this and those *mycelia* forming cloudy flocks in and decomposing various saline solutions, &c., described as species of *Hygrocrocis*, *Leptomitus*, &c. The decay of wood, again, is often greatly accelerated by the growth of the mycelium of Fungi, which seems to decompose the organic compounds in the wood in the same way that the Yeast does those in organic liquids. A general law indeed appears to prevail throughout the Fungi, that their nutrition differs from that of all other plants in depending *exclusively* on the absorption and decomposition (with the evolution of carbonic acid) of organic compounds, therefore consisting of the performance of the operation of *fermentation* on the organic matters upon which they feed. Details upon the microscopic phenomena attending fermentation produced by Fungi will be found under YEAST, VINEGAR-PLANT, TORULA, PENICILLIUM, and SCHIZOMYCETES.

The fermentation of animal substances, and of vegetable substances containing abundance of nitrogen, in which ammonia is liberated, is generally called *putrefaction*, or the *putrefactive fermentation*. This process has been shown to be produced by the growth of living organisms resembling those causing the fermentations alluded to in the foregoing paragraphs; and when the organic liquids are thoroughly boiled and sterilized, they may be kept indefinitely without change. These organisms appear in myriads during the decomposition which takes place when a piece of meat, &c., slices of potato, fleshy Fungi, &c., are kept moist and exposed to the air for some days in warm weather; and they continue to multiply until the putrefaction is complete, when they die away. It is a question perhaps whether they liberate the ammonia and carbonic acid by a kind of respiration while living, or as an excrement.

One point of interest connected with the fermentation-plants must not be passed over, viz. that the supposed distinction between the chemical processes of nutrition in animals and plants, falls to the ground when these Fungi are taken into consideration; as they do not live by converting *inorganic* substances into organic compounds, but, like animals, decompose ready-formed organic compoumds into others and into their inorganic elements.

BIBL. Turpin, *Mém. Muséum*, 1840; Bail, *Flora*, 1857, 417; Mulder, *Chem. of Veg. and An. Phys.*; Liebig, *Lett. Chemistry*, 1231; Gmelin, *Organ. Chem.*; Löwig, *Chem.*

org. Verb. i. 223; Mitscherlich, *Pogg. Annal.* lv. 224; *Lehrb.* 4. ed. 371; Cagniard Latour, *Pogg. Ann.* xli. 193; Schwann, *ibid.* 184; Ure, *Biblioth. Genèv.* 1839; Helmholtz, *Müller's Archiv*, 1843, 453; Reess, *Alcoholgährungs-Pilze*, 1870; Pasteur, *Etudes s. l. Vinaigre*, 1868, *s. l. Vin*, 1872, *s. l. Bière*, 1876; V. Tieghem, *Ann. Sc. Nat.* viii. 1868; Frémy, *Géner. d. Ferments*, 1875; Schutzenberger, *Ferment.* 1875; Gayon, *Ann. Sc. Nat.* 1875, i. 5; Muntz, *Ferment, Compt. Rend.* 1878 (*Jn. Mic. Soc.* 1878, 23); Lister, *Qu. Mic. Jn.* 1878, xviii. 177; Nägeli, *Theor. d. Gährung*, 1879; Sachs, *Bot.* 254; Tyndall, *Putrefaction &c.* 1881. See also TORULA and PENICILLIUM.

FERNS.—This class of Flowerless Plants offers very many points of interest to the microscopist; and indeed the use of magnifying-instruments is indispensable in their examination for botanical purposes. The

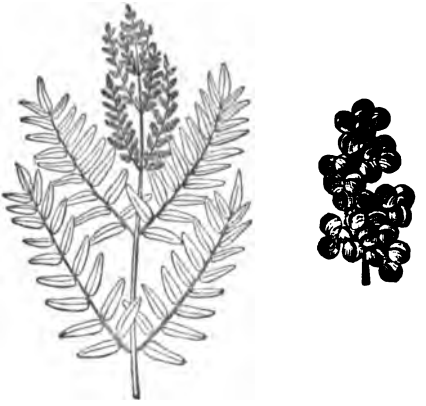
Fig. 221.

Scolopendrium vulgare; underside of frond.
Nat. size.

Ferns are characterized by the position of their spore-cases or fruits (thecæ, sporangia, or capsules), which are collected into what to the naked eye look like spots, streaks, or patches of a brown colour (*sori*) at the back or lower surface of the leaves or fronds (fig. 221), or at their margins,—these *fertile* leaves either resembling the rest, or being modified in a manner which more or less disguises their nature, as in what are miscalled 'flowering Ferns' (*Osmunda* (figs. 222 & 223), *Botrychium*, &c.).

The Ferns possess a stem which is more or less developed in different cases: in our native kinds it is either a slender, horizontal, subterraneous rhizome or rootstock, or a thick, short, erect one rising little above the ground; but in foreign kinds this erect

Fig. 222. Fig. 223.



Osmunda regalis.
Fig. 222. Upper part of a frond, 1-6th nat. size.
Fig. 223. A fertile pinnule bearing thecæ without parenchyma. Magnified 10 diams.

stem attains the forms and dimensions of a tree, growing up into a tall unbranched columnar stem, sometimes more than fifty feet high. The anatomical structure of the stem of the Ferns is peculiar and special, depending on the character and arrangement of the fibro-vascular bundles (see TISSUES, VEGETABLE), which afford the best examples of that form of elementary tissue called the SCALARIFORM DUCTS. The creeping rhizomes are often clothed more or less thickly (as are also the leaf-stalks) with brown membranous scales called RAMENTA; and these often afford elegant microscopic objects, from the peculiar arrangements of the cells. The leaves are generally very greatly developed; and the green blade is of more or less complex structure in different genera. In the *Hymenophylla*,

Filmy Ferns, the leaf is ordinarily a mere membrane of a single layer of cells, through which ramify scalariform ducts, to form the veins—consequently there are no stomata; but in the other orders, in *Pteris* for example, the leaf has an upper and lower epidermis with stomata, with loose cellular tissue (*mesophyllum*), between and through which ramify the fibro-vascular veins: the epidermal cells often have elegantly zigzagged or waving side-walls, which produce a pleasing appearance in the sections of the structure obtained in slices shaved off horizontally from the surface of the leaf.

The mode of ramification of the veins or nerves of the leaves is important in systematic Filicology, and may be observed for such purposes by immersing the dried leaflets in turpentine or oil, or mounting them in Canada balsam. The collections of sporangia or capsules on the back of the leaves sometimes occur on all of these; in other

Fig. 224.

Nephrodium.
Pinnule with indusiate sori.
Magnified 10 diameters.

cases there are *barren* leaves and *fertile* leaves, the latter of which are generally somewhat modified in form, deprived of a certain portion of the green expanded structure, and reduced occasionally to a mere ramification of veins or ribs supporting the sporangia (fig. 223).

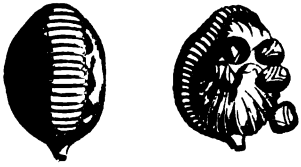
The groups of sporangia are called *sori*; they differ much in form and arrangement, and are either naked (*Polypodium*), or covered by a special membranous structure, more or less continuous with the epidermis of the lower surface of the leaf, called an *indusium* or *involucre* (fig. 224); sometimes this indusium is so constructed as to form a kind of cup (figs. 127 & 151), which, again, exhibits a great variety of modifications. (See SORI and INDUSIUM.)

The *thecæ* or *sporangia* are usually collected in great numbers in the sori; and consist of minute stalked sacs or cases, composed of simple cellular membrane, the cells of which are either all alike (OPHIOGLOSSUM), or a row of them running almost round the sac are modified by the thickening of their walls, so as to form an elastic band (*annulus*), which causes the bursting of the sac when ripe. In the Polypodiaceæ the annulus starts from the stalk of the capsule (fig. 225); in *Hymenophyllum* and

Fig. 225.

Polypodium verrucosum.
Stalked thecæ with annuli. Magnified 25 diameters.

Fig. 226. Fig. 227.



Ceratopteris thalictroides.
Fig. 226. Theca. Magn. 50 diams.
Fig. 227. Do. bursting. Do.

Trichomanes it runs round in an oblique line (like the ecliptic line on a globe); in *Gleichenia* it is also oblique (fig. 231); and in *Schizæa* and *Aneimia* (fig. 12, p. 41) &c. it forms a kind of cap on the summit of the case.

Fig. 228. Fig. 229. Fig. 230.

Ceratopteris thalictroides.
Figs. 228-230. Spores. Magn. 150 diams.

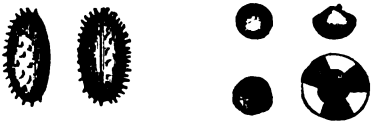
Fig. 231.

Gleichenia.
A theca. Magnified 40 diams.

These membranous sporangia are filled with spores having a double coat, like pollen-grains; and, as in these, the outer coat is ordinarily coloured, and either smoothish or marked with points, streaks, ridges, or reticulations (figs. 228-230, 232-235). (See SPORES.)

Fig. 232. Fig. 233.

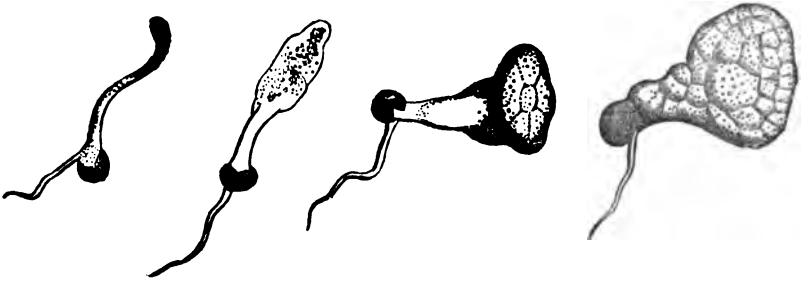
Fig. 234. Fig. 235.



Spores of Ferns.
Fig. 232. Aneimia asplenifolia.
Fig. 233. Polypodium aureum.
Fig. 234. Cystopteris fragilia.
Fig. 235. Pteris longifolia.
Magnified 100 diameters.

The reproduction of the Ferns by their spores exhibits some very remarkable phenomena. When the spores are sown, they germinate after a time by a protrusion of the inner coat as a delicate membranous pouch (fig. 236), which elongates and becomes divided by septa into an articulated cellular filament; some of the cells emit slender tubular, not septate, filaments, forming radical hairs; and while these remain uncoloured, the larger cells from which they

Fig. 236. Fig. 237. Fig. 238. Fig. 239.



Germination of Pteris longifolia. Magn. 100 diams.

arise acquire chlorophyll-granules. The young *prothallium*, as it is called, increases in size by cell-division, and at length acquires somewhat the form of a heart (figs. 236-239). Some of its cells produce, upon the margin or the under surface, the trichomatous structures called *antheridia*; which consist of stalked cellular bodies, of simple but peculiar structure, in the interior of which are developed minute cellules containing ciliated spiral filaments, the *spermatozoids*. These are corkscrew-shaped, with 3 or 4 coils, and the front end finely ciliated. On the bursting of the antheridial sac, they escape, not only from this, but from their own parent-cells, and swim about actively in the water by the aid of their vibratile cilia (Pl. 40. fig. 34).

The antheridia are often formed in large numbers, and the prothallium goes on producing them as long as it exists; but at a period somewhat later than that of the earlier antheridia, there appear near the middle, at the front of the under surface of

the prothallium, other cellular bodies, of more complex structure, which are the *archegonia* or ovule-like bodies. The archegonium consists of a cellular papilla, composed of a few colourless cells, with a canal running down its centre (an intercellular passage) leading to a cell (*embryo-cell*) at the bottom, contained in a cavity (*embryo-sac*) in the substance of the prothallium. The ciliated spiral filaments make their way down this canal, like the pollen-tubes through the micropyles of Phanerogamous ovules; and then the embryo-cell becomes developed into an embryo, which soon exhibits rudimentary leaves and rootlets, bursts out from the cavity of the prothallium, which decays away, and grows up into the ordinary leaf-bearing stem of the Ferns (fig. 240). The prothallia bear a variable number of archegonia, but not nearly so many as of antheridia; and they exhibit, in most fully-developed specimens, a number of effete organs of both kinds, which are readily distinguished by the deep-brown colour assumed by the membranes bounding their cavities.

Fig. 240.

Pteris, seedling.

The characters of the prothallium of the *Ophioglossaceæ* differ somewhat from the ordinary forms: the prothallium is developed in the soil, several inches below the surface, and is of a whitish-yellow colour internally, being destitute of chlorophyll and starch; its external surface is brown. The antheridia are chiefly produced upon the upper side, the archegonia below, both immersed in the substance of the prothallium. The spermatozoids are described as being larger than in Polypodiaceæ.

The Ferns produce also *gemmæ* on the leaves of full-grown plants; and even the prothallia are capable of vegetative multiplication; for if their archegonia are all abortive, they go on vegetating for a long time, and produce new prothallia, by some of their marginal cells budding out and repeating the original mode of growth of the spore itself. These *innovations* usually bear antheridia alone, and not archegonia.

The Ferns are divided into six orders.

Gleicheniaceæ. Sori dorsal, of few thecæ, naked; thecæ opening vertically by a broad transverse complete annulus.

Polypodiaceæ. Sori dorsal or marginal, subglobose; thecæ numerous, with or without an indusium, usually stalked, more or less completely surrounded by a vertical annulus, and bursting transversely (except in Hymenophylleæ).

Osmundaceæ. Thecæ two-valved, opening across the apex, with a short horizontal annulus; vernation circinate.

Schizæaceæ. Thecæ two-valved, opening down the side, crowned by a complete operculiform annulus; vernation circinate.

Marattiaceæ. Thecæ opening by a lateral slit or a pore at the apex; no annulus, usually united into concrete masses (synangia); vernation circinate.

Ophioglossaceæ.—Thecæ deeply two-valved, opening down the side nearly to the base; no annulus; vernation erect.

Bibl. Berkeley, *Crypt. Bot.* 507; Presl, *Pteridograph.* 1836; Payen, *Bot. Cryptogam.* 1850; Bischoff, *Kryptogam. Gewächse*, 1828; Mohl, *Martius's Plant. Cryptog. Brasil.*; Moore, *Index Filicum & Handb. of Br. Ferns*; Newman, *Br. Ferns*; Henfrey, *Devel. of Ferns from Spores, Linn. Trans.* xxi. 117, 1853; *Reproduct. of Cryptogamia, Ann. N. H.* 1852; Hofmeister, *Entwickelung, Sächs. Ges.* 1857, v.; Reess, *Jahr. wiss. Bot.* v. 1866; Strasburger, *Befruchtung, Jahr. wiss. Bot.* 1869, vii. 390; Kny, *Monatsb. Berl. Akad.* 1869; *id., Jahr. wiss. Bot.* vii. 1; Janczewsky, *Bot. Zeit.* 1872, 418; Sachs, *Bot.* 415; Hooker, *Syn. Filic.* (*figs. of all gen. and description of all species*); Kny, *Ann. N. H.* 1870, v. 233; Strasburger, *ibid.* 1870, v. 331; Smith, *Hist. Filic.* 1875; Waldner, *Ferns of Germany*, 1880; Blair, *European Ferns*, 1881.

FIBRINE.—Fibrine exhibits very numerous fine fibres; and is soluble in, or rendered so transparent by acetic acid, as to be invisible. Its chemical relation to the other proteine-compounds has not been satisfactorily determined. A substance resembling fibrine in many of its characters, if not identical with it, occurs upon the surfaces of inflamed membranes, &c.; in these cases it generally includes the other elements of inflammation, and almost always a number of minute granules of fat.

Fibrine is coloured by the test-liquids of Millon and Pettenkofer.

According to Schmidt's experiments, fibrine does not pre-exist in blood, but is formed by the chemical combination of a fibrinogenous substance occurring in the blood-plasma with a fibrino-plastic matter contained in the blood-corpuscles, which escapes from them; more recently, Schmidt considers the separation of fibrine to depend

upon the action of a ferment (see Frey, *Hist.* 16, and M. Baker, *Phys.* 98).

The fibrinous plasma of the lower animals resembles fibrine in many respects, but does not separate in fibres.

FIBROINE. — The principal chemical constituent of silk, cobwebs, and the horny skeleton of sponges; but the latter is now considered to be composed of a new substance, *spongine*. In the pure state, it is white, insoluble in water, alcohol, ether, acetic acid, and ammonia.

Bibl. That of Chemistry, animal.

FIBRO-PLASTIC TISSUE. See Tissue, fibro-plastic.

FIBROUS and FIBRO-VASCULAR BUNDLES. See Tissues, vegetable.

FIBROUS STRUCTURES of Plants. —This term is somewhat equivocal, and requires a little explanation here. In common language all vegetable substances are termed fibrous which can be separated into more or less fine threads possessing a certain degree of tenacity; special examples are furnished by those forming the materials for textile fabrics. But the anatomical or microscopical structures comprehended here are exceedingly varied, including not only liber-fibres, but spiral vessels, and even hairs. Thus, Flax (Pl. 28. fig. 2) is the liber of *Linum usitatissimum*; Hemp (Pl. 28. fig. 6) of *Cannabis*; Jute (Pl. 28. fig. 3) of *Corchorus capsularis* &c.; Puya (Pl. 28. fig. 26) of *Bœhmeria Puya*, and the material of Chinese grass cloth (Pl. 28. fig. 25) of *Bœhmeria nivea*; Coir (Pl. 28. fig. 4) the liber-like fibre of the husk of the cocoa-nut; Manilla hemp (Pl. 28. fig. 7) of the fibro-vascular bundles of *Musa textilis*; New-Zealand flax of *Phormium tenax*; Esparto-grass of *Lygeum esparto*; and Cotton (Pl. 28. fig. 1) consists of the hairs covering the seeds of species of *Gossypium*. These and similar substances are also spoken of under Liber, Hairs, and under their respective heads.

In botanical language, the word fibre has come into use in two very different senses. First, any long cell attenuated to a point at both ends, and with its walls thickened with ligneous secondary deposits, is called a *fibre* by some authors. Thus the term *woody fibre* is applied to the shorter cells of this kind which make up the substance of most solid woods; while the term *liber-fibre* is applied (with more justice) to the often extremely elongated wood-tubes which form the elements of the liber of Dicotyledons and the woody part of the fibro-vascular bundles of the Monocotyledons. (See Tissues, vegetable.) The characters of structures of this kind will be given under Liber and Wood. Secondly, the term *fibre* is applied to the secondary deposits upon the walls of cells, vessels, ducts, &c., which, instead of forming continuous pitted layers, take the pattern of spiral or analogous lines, and, by increasing in consistence, subsequently form real fibres, often elastic and unrollable, of firmer substance than the cell-wall upon which they were originally deposited. The numerous modifications of these *fibrous deposits* upon the walls of cells are spoken of under the heads of Spiral Structures, Vessels, and Secondary deposits.

It must not be omitted here that the walls of many cells and liber-fibres, which appear at first sight to be composed of homogeneous laminæ, may often be made to exhibit spiral streaks, by the use of reagents and maceration; indeed they present themselves during the natural dissolution of the membranes of some of the Oscillatoriaceæ (Ainactis, Schizosiphon—Pl. 8. figs. 13, 15). Hence some authors have recently recurred to the old notion that all vegetable membranes are formed of fibres cemented or blended together. This is again strongly combated by others, as regards the *primary membrane* of cells. We enter more particularly into the details under the article Spiral Structures of Plants.

FI'CUS, Linn. (Figs).—A large genus of Urticaceæ (Dicotyledons), some of which possess a remarkably thick epidermis and curious pseudo-glandular structures connected with it. *Ficus elastica*, one of the plants yielding india-rubber, now commonly grown in pots in rooms, is a good example. The clavate bodies (Pl. 48. fig. 27) of Meyen, developed in cavities in the leaf, beneath the epidermis, contain crystalline deposits. (See Glands and Raphides.)

FILAMENTOUS STRUCTURES of Plants.—This name would be more applicable than *fibrous structures* to such substances as Cotton, which consists of elongated hairs (Pl. 28. fig. 1), and indeed to all elongated cellular filaments with thin and collapsing walls. It would include all long vegetable hairs, like those forming the coma on many seeds (Poplars, *Asclepias*, *Gossypium*, &c.); also those forming felty coatings on the epidermis, as in many Compositæ, &c. It is also applicable to the

cells of most of the Confervoid Algæ, to the mycelium (flocci) of Fungi, and to the medullary layer of the lichens. Many other instances will suggest themselves to the microscopist.

FILA'RIA, Müll.—A genus of Entozoa, of the order Nematoidea.

Char. Body filiform, very long, nearly uniform; head not distinct from the body; mouth round or triangular, naked or with papillæ; white, yellowish, or red, from 48 to 100 times as long as broad; œsophagus short, tubular, narrower than the intestine; anus terminal, or nearly so; spicula two, of unequal size, more or less twisted; vulva situated very near the anterior extremity.

Several species, many of which have been imperfectly examined. They are most commonly found in the abdominal cavity and between the peritoneal folds of mammalia and birds, in the blood and the air-cells of the latter, sometimes in the subcutaneous cellular tissue. Species are also met with in reptiles, fishes, and insects.

F. medinensis. The hair- or Guinea-worm. Common in the intertropical regions of the old world. Length 6 to 10″; breadth 1-20 to 1-10″. *F. bronchialis* occurs in the human bronchi; *F. lachrymalis* in the lachrymal gland; *F. oculi* (*papillosa*) in the globe of the eye, or beneath the conjunctiva; *F. immitis* in the heart of the dog; *F. rhytipleurites* in the cockroach, &c.

F. sanguinis is capillary, uniform, without papillæ, the neck narrowed, the tail of female simple, bluntly pointed, the vulva close to the head, and the anus near the tip of the tail; length of adult 3½″, of embryos $\frac{1}{150}$–$\frac{1}{75}$″. It is found in the immature form in human blood and urine, in chyluria and endemic hæmaturia. The adult form occurs in the subcutaneous connective tissue of the scrotum, &c.

Two species occur in fresh water, under the leaves of aquatic plants:

F. aquatilis. Fem. white, constricted behind the spherical head; tegument not striated; œsophagus capillary, very long, sinuous; tail gradually narrowed to a curved point; vulva anterior to the middle of the body; length 3-10 to 4-10″; breadth 1-250″.

F. lacustris. Fem. reddish-white, slightly narrowed in front, but without a constriction; mouth very small, lateral, and oblique; œsophagus filiform, very long, nodose at its origin; tail conical, obtuse, terminating obliquely in a very small point; tegument not striated; vulva behind the middle; length 1-2″; breadth 1-140″.

Bibl. Dujardin, *Helminth.* 42; Diesing, *Helminth.* ii. 263; Küchenmeister, *Parasiten,* 304; Lewis, *San. Comm. 8th Rep., Calcutta,* 1872; Leuckart, *Parasit.* 1879, 65 (fig.); Gruby and Delafond, *Compt. rend.* xlvi. 1217; Leidy and Welch, *Mn. Mic. Jn.* 1873, 157; *Ann. N. H.* 1878, ii. 199; Cobbold, *Parasites,* 1879 (*most complete literature*).

FILELLUM, Hincks.—A genus of marine Hydroid Polypi, fam. Lafoëidæ.

1 species: *F. serpens*; common on the larger Sertulariidæ, especially *S. abietina.*

Bibl. Hincks, *Brit. Zooph.* p. 214.

FIR. See Pinus, Coniferæ, and Wood.

FISCH'ERA, Schwabe.—A genus of Oscillatoriaceæ (Confervoid Algæ).

Char. Filaments irregularly branched, composed of uniserial cells, with interstitial subglobose cell; surrounded by mucus, forming an amorphous gelatinous stratum.

F. thermalis. On the walls of warm springs (Rabenhorst, *Fl. Alg.* ii. 285).

FISSIDEN'TEÆ.—A family of operculate Acrocarpous (sometimes cladocarpous) Mosses, of gregarious or cæspitose habit, with simple or much-branched stems. The leaves are amplexicaul (fig. 242), composed of minute parenchymatous cells, closely are-

Fig. 241. Fig. 242. Fig. 243.

Fissidens bryoides.

Fig. 241. A plant of F. bryoides. Magn. 5 diams. Figs. 242 & 243. Leaves detached. More magnified to show the appendage.

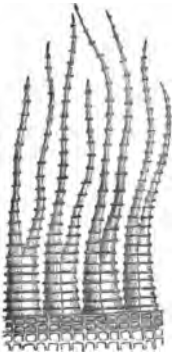
olated, often very papillose, produced at the back and point into a lamina beyond the leaf (figs. 243–246), whence *three* parts are distinguished in the latter:—1, the true horizontal blade; 2, the dorsal lamina, arising vertically from the back of the nerve; 3, the apical lamina, the preceding lamina produced beyond the true horizontal blade

Fig. 244.

Fig. 245.

Fig. 246.

Fig. 247.



Fissidens bryoides.

Figs. 244, 245, 246. Sections of 243, at various heights rom the base.
Fig. 247. Fragment of peristome. Magn. 100 diams.

of the leaf in a two-edged form, on each side of the nerve. Capsule equal, rarely annulate. British genus: FISSIDENS.

FIS'SIDENS, Hedw.—A genus of Fissidenteæ. Character that of the family. Inflorescence monœcious or dicœcious, terminal on the main stem or on short secondary branches. Montagne has separated the species with an entire calyptra under the generic name of *Conomitrium*.

F. bryoides (fig. 241), not uncommon, is a most elegant little moss.

BIBL. Wilson, *Bryol. Brit.* p. 301.

FISSURI'NA, Reuss.—A compressed *Lagena*, with slit-like aperture. It has the same relation to *Lagena* that *Lingulina* has to *Nodosaria*.

BIBL. Reuss, *Monogr. Lagen.* in *Sitz. Ak. Wiss. Wien*, xlvi. i. 1863.

FISTULI'NA.—A genus of Polyporei (Hymenomycetous Fungi), characterized by the papillæ of the fleshy hymenophorum being at length elongated and forming distinct tubes, which call to mind those of *Solenia*.

Fistulina hepatica occurs not unfrequently on old oaks, on which it sometimes attains an enormous size, and when well dressed is excellent for culinary purposes. The flesh when cut resembles that of beet-root.

BIBL. Huss. i. t. 65; Berk. *Outl.* 257, tab. 17. fig. 1; Cooke, *Handb.* 292.

FLABELLI'NA, D'Orb.—One of the *Nodosarinæ*. It is dimorphous—that is, having two successive plans of growth:—the first spiral, like that of *Cristellaria*; the later rectilinear, like that of *Nodosaria*, or rather of *Frondicularia*, which latter it resembles in its chevron-shaped flattened chambers. It differs from *Frondicularia* in an eccentricity, or tendency to coil, in the earliest chambers, and thus connects the Stichostegian with the Helicostegian groups. It is to *Frondicularia* as *Vaginulina*, *Marginulina*, and *Planularia* are to *Nodosaria*. To many large flat *Cristellariæ* (*C. cassis*) semigeniculate chambers give a Flabelline feature; but pure *Flabellinæ* are rare in the recent state (Batsch figured one) and in Tertiary strata. In the Chalk (*Fl. rugosa*, Pl. 23. fig. 38), Gault, Lias, and other Secondary strata, *Flabellinæ* abound.

BIBL. D'Orbigny, *For. Foss. Vien.* 92; Morris, *Brit. Foss.* 35; Parker and Jones, *Ann. N. H.* 3. xii. 136; Carpenter, *Introd. For.* 160, 164.

FLAGELLA'TA. See INFUSORIA.

FLANNEL, NATURAL.—This term has been applied to sheets or layers of a harsh fibrous texture, sometimes found covering meadows, rocks, &c. after an inundation. It consists of the interwoven filaments of Confervæ, with adherent or entangled Diatomaceæ, Infusoria, crystals of carbonate of lime, &c. To the naked eye it closely resembles a piece of coarse or loosely woven cloth. Similar layers are frequently found upon the margins of pools during the summer. As the water evaporates, the Confervæ and other organisms remain supported upon the stems of rushes, or blades of grass, and, when dry, form the yellowish, greenish, or greyish layers of the so-called natural flannel.

See PAPER, METEORIC.

FLAX.—The liber-fibres from the stems of the Flax-plant, *Linum usitatissimum* (nat. ord. Linaceæ, Dicotyledons). Under the microscope, the fibres (Pl. 28. fig. 2) are readily distinguished from those of Cotton by the form and consistence,—being round and attenuated to a point at each end, and of a firm woody consistence, which prevents them from collapsing, and having pits in the wall. New-Zealand Flax is a totally differ-

ent substance (PHORMIUM). See FIBROUS STRUCTURES of Plants, and LIBER.]

FLEA. See PULEX.

FLINT.—This is a subtranslucent variety of silica, forming nodules or bands in most limestones. The organisms in flint are the same as those met with in the chalk or other limestone of which the flint forms part, as a pseudomorphic replacement of the original amorphous carbonate of lime by silex, generally where decomposing organic matter induced the conditions of change.

Much of the flint of the South of England has been formed out of the calcareous mud, crowded with small sponges, spicules, and Foraminifera, which hold the same position in the flint as they did in the cretaceous ooze. Large sponges are often included, with shells of Mollusks and Echinoderms, scales of Fishes, and sporangia of Desmidiaceæ, formerly recorded as distinct organisms (*Xanthidia*).

The crystallized calcite of Echinoderms and some shells is not replaced by silex in limestones, but remains as cavities in exposed flint-masses. Many varieties of limestone, viz. polyzoan limestone in France, freshwater limestone in France and Turkey, orbitoidal limestone in Jamaica, oolitic limestone at Portland and elsewhere, are converted into flint, hornstone, &c. of fine or coarse grain according to the constitution of the original limestone.

Wallich has suggested that chalk-flints are due to the nearly continuous protoplasmic layer among extensive sponge-growths having become silicified.

In the examination of flint, thin sections should be made by grinding and polishing; some kinds exhibit the organisms contained in them best by reflected, others by transmitted light. Some specimens, in which they are abundant, will exhibit them well in chips removed by a hammer.

See AGATE and CHALK.

BIBL. That of AGATE and CHALK; Ehrenb. *Ann. N. H.* 1838, ii. 162; Turner, *Phil. Mag.* 1833; Ansted, *Ann. N. H.* 1844, xiii. 248; Bowerbank, *ibid.* 1847, xix. 240; Charlesworth, *Geol. Jn.* 1847, i. 29; Church, *Proc. Chem. Soc.* 1862; id. *Chem. News*, v. 95, and *Phil. Mag.* (4) xxiii. 95; Sutherland, *Geol. Mag.* ii. 220; Johnson, "*Flint*," 1871; Jones, *Proc. Geol. Assoc.* iv. 439; Wallich, *Qu. Jn. Geol. Soc.*, Feb. 1880; Sollas, *Ann. N. H.*

FLORID'EÆ or RHODOSPO'REÆ.—An order of Algæ. Red sea-weeds, some of the common species of which must be familiar to every one, as the delicate feathery or leaf-like plants brought away by most visitors to the sea-coast; and the red colour, more or less permanent or fleeting, is a pretty general characteristic of this order —varying however to purple, brown, and mixed tints of red, green, and yellow, and dirty white; the green colour of the chlorophyll being often obscured by a red pigment, *phyco-erythrine*. They chiefly grow in deeper water than the other sea-weeds, and are met with in finest and darkest colour in deep tide-pools of sea-water, especially on the side facing the north, where they are overhung by the larger dark-coloured Algæ, and thus shaded from the sun's rays. The greater number do not grow more than six inches high, few more than two feet. The simplest forms are filaments composed of cylindrical cells attached end to end; they next rise to a gelatinous or cartilaginous expansion, composed of such filamentous structures adherent in layers, and forming a compact frond of definite shape. These are said to be of *filamentous structure*. Others have the frond composed of a number of polygonal cells, evenly arranged, and with thick walls, or, as some state, an intercellular substance binding them all together into a mass; these are technically said to be of *cellular structure*. Sometimes all the cells of the frond contain colouring-matter, sometimes only those of the surface, or of a shallow superficial stratum.

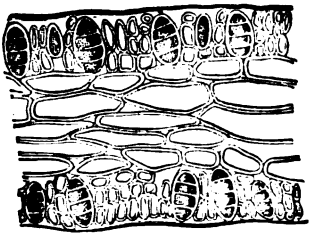
The general external appearance of the Red Sea-weeds is very varied. Sometimes the fronds are like little leafless bushes; at others they form broad laminæ; sometimes the lower part is stalk-like, and the upper parts spread into leaf-like lobes. In *Delesseria* we have a close imitation of a regularly formed leaf of one of the higher plants. The leaf-like forms are either simple, lobed, or exquisitely pinnate or feathered; and the Rhodosperms of warmer climates exhibit most elegantly reticulated fronds. Some of these plants deposit carbonate of lime in their tissues in such quantity that they become quite stony, so that, the vegetable form alone remaining, they are commonly mistaken for true corals (see CORAL). By placing these *corallines* and *nullipores* in vinegar or dilute hydrochloric acid, the lime is removed, and the cellular vegetable organization may be recognized. The tropical forms of the corallines are far more varied and beautiful than our own.

Red or colourless albuminous crystalloids are found in some of the Florideæ.

Three kinds of reproductive structures occur in these plants, viz. :—1, *tetraspores*; 2, *spores*; 3, *spermatozoids* or *antherozoids*.

The *tetraspores* or *tetragonidia*. These structures are of similar organization throughout the order. They consist of an

Fig. 248.



Rhynchococcus coronopifolius.
Section of the frond with tetraspores.
Magnified 200 diameters.

oblong or globular external cell or sac (*perispore*), at first filled with granular contents,

Fig. 249.

Ptilota plumosa.
Section of frond with tetraspores.
Magnified 200 diameters.

which contents subsequently separate into four portions, called sporules, either by three transverse fissures (fig. 248); by two fissures at right angles, cutting them into quarters like an orange; or by tri-radiate fissures which part them into the 'tetrahedral' group (fig. 249) so often found in the division of spore- and pollen-cells: the last two occur in the spherical tetraspores. The tetraspores are rarely found collected in any capsular structure; but in the Corallines (fig. 141), and in some few foreign genera, they are grouped in hollow cases (*conceptacles*, fig. 250). In many instances, however, they are found in pod-like bodies (*stichidia*, Pl. 4. fig. 13 *b*), either formed by metamorphosis of portions of the lobes or lobules of the frond (*Plocamium*), or arising independently on it. In others the tetraspores are naked (*Callithamnion*), scattered over the sides or fixed at the tips of the branches. In the majority of cases, however, these bodies are immersed in the substance of the lobes or lobules, not evident externally except by the darker colour of the frond at the point where they are collected; a lens is then required for their detection; they here appear to be formed either of the cells of the surface or of others immediately subjacent. Harvey, Thwaites, Pringsheim, and others regard these bodies as *gemmules* or *gonidia*; Decaisne, J. Agardh, and other Algologists regard them as true spores. Pringsheim states that in *Ceramium* they grow up at once into a thallus.

Fig. 250.

Hildenbrant sanguinea.
Section of a conceptacle containing tetraspores.
Magn. 50 diams.

The true *spores* are simpler structures than the tetraspores, but mostly occupy a more important position. They are never scattered through the frond, but always grouped in definite masses, generally enclosed in a special capsule, *conceptacle* or cystocarp, which is furnished with a closed tube or *trichogyne* (Pl. 4. fig. 12 *c*). In fertilization, the spermatozoids conjugate with the trichogyne (Pl. 4. fig. 12 *a*). Its basal cell then subdivides, the new cells forming a sporiferous heap; as in *Nemaleon* (and *Batrachospermum*). Or, the trichogyne-cell takes no direct part in the formation of the spores, which are produced after fertilization in laterally arising new cells, as in the Ceramiaceæ &c. In *Dudresnaya* the elongated trichogyne is spiral at the base. After its fertilization, cells sprout from beneath it, and elongate to form connecting tubes, These pass over the ends of the fructiferous branches, which are short with an enlarged terminal cell, becoming soldered with them at the points of contact, the contents being mixed: each connecting tube conjugates with several of the fertile branches.

The simplest form of the *spore-fruit* con-

sists of spherical masses of spores, attached to the wall of the frond, or imbedded in its substance without a proper conceptacle, in which latter case the cells surrounding the mass of spores are devoid of colouring-matter: such a fruit is called a *favellidium*, and occurs in *Halymenia*; and the same name is ordinarily applied to fruits of similar structure not perfectly immersed, such as those of *Gigartina*, *Gelidium*, &c., where they form tubercular swellings on the lobes. In some cases the tubercles present a pore at the summit, when mature, through which the spores find exit. When such a fruit is wholly external, as in *Ceramium* and *Callithamnion*, it is called a *favella*. The *coccidium*, characteristic of *Delesseria* (Pl. 4. fig. 5 *e*), *Nitophyllum*, &c., which is nearly related to this, either occurs on lateral branches, or is sessile on the face of the frond, and consists of a hollow case with thick cellular walls, containing a dense tuft of angular spores attached to a central column. It is generally imperforate, but occasionally exhibits a pore through which the spores escape. The *ceramidium* is the most complete form of the conceptacular fruit, and is an ovate or urn-shaped case, furnished with an apical pore, and containing a tuft of pear-shaped spores arising from the base of the cavity. The walls are usually thin and membranous, and the hollow space considerable, as in *Polysiphonia*, *Laurencia*, *Dasya* (Pl. 4. fig. 9 *c*), &c.

From the account given by Pringsheim, of *Ceramium*, it would appear that these (capsule-) spores first produce a kind of prothallium, somewhat in the manner of the higher Cryptogamia.

Peculiar bodies, forming external warts, and composed entirely of vertical fibres, but without spores, called *nemathecia*, are sometimes confounded with the conceptacular fruit, and are probably immature forms of it.

The *spermatozoids* are found in peculiar structures, to which the name of *antheridia* has been applied, from the supposed analogy to the organs so called in the other Cryptogamous plants. The *antheridia* are produced pretty much in the same situations as the other organs of fructification, and are often developed on different individuals. They are collections of very small colourless cells (Pl. 4. fig. 12*b*); sometimes collected into a bunch, as in *Griffithsia*; sometimes enclosed in a transparent tube, as in *Polysiphonia*; clothing a kind of irregularly-shaped flat plate, as in *Laurencia*; or occupying portions of the general surface of the thallus. Each of the minute cells contains a rounded motionless spermatozoid.

Synopsis of the Families.

RHODOMELACEÆ. *Frond* cellular, areolated or articulated. *Ceramidia* external. *Tetraspores* in rows, immersed in ramuli, or contained in proper receptacles (*stichidia*).

LAURENCIACEÆ. *Frond* cellular, continuous. *Ceramidia* external. *Tetraspores* scattered, immersed in the branches and ramuli.

CORALLINACEÆ. *Frond* calcareous or crustaceous, rigid. *Ceramidia* external, containing the tetraspores.

DELESSERIACEÆ. *Frond* cellular, continuous, areolated. *Coccidia* external. *Tetraspores* collected into definite clusters (*sori*).

RHODYMENIACEÆ. *Frond* cellular, continuous, the superficial cells minute. *Coccidia* external. *Tetraspores* scattered through the frond, or forming undefined, cloud-like patches.

CRYPTONEMIACEÆ. *Frond* fibroso-cellular, composed of articulated fibres connected together by gelatine. *Favellidia* immersed in the frond or sub-external. *Tetraspores* immersed in the frond.

CERAMIACEÆ. *Frond* filiform, consisting of an articulated filament, simple or coated with a stratum of small cells. *Favellæ* naked berry-like masses. *Tetraspores* external, or partially immersed.

PORPHYRACEÆ. *Frond* plane and exceedingly thin, or tubular and filiform, of a purplish colour, with oval spores in sori, and tetraspores scattered over the frond.

BIBL. Harvey, *Mar. Algæ*, 1849, & *Phyc. Brit.*; Kützing, *Phycol. gen.*; Thuret, *Ann. Sc. Nat.* 3 sér. xvi. 5, 4 sér. iii. 5; Derbès and Solier, *ibid.* 3 sér. xiv. 261, 4 sér. v. 209; Pringsheim, *Berl. Ber.* 1855; *Ann. Sc. Nat.* 4 sér. iii. 363; *Bot. Zeitung*, xv. 784; Henfrey-Masters, *Bot.* 1878; Bornet and Thuret, *Ann. Sc. Nat.* 1867, vii. 166; Rosanoff, *Compt. Rend.* 1866; Cohn, *Schultze's Archiv*, iii. 24; Askensky, *Bot. Zeit.* 1867 (*col. matter*); Solms-Laubach, *Bot. Zeit.* 1867; Sachs, *Bot.* 1874, 291.

FLOSCULA'RIA, Oken, Ehr.—A genus of Rotatoria, of the family Floscularieæa.

Char. Attached; eyes two, red; carapace single; rotatory organ divided into more than four lobes, with elongated cilia radiating from their extremities.

Eyes sometimes absent in the adult animals. Sheath or carapace frequently so transparent as to be scarcely distinguishable. Rotatory organ with five or six lobes; the number, however, appears variable; for Ehrenberg states in one place that the lobes are five or six, in another that they are always six. The so-called proboscis is probably only one of the lobes of the rotatory organs; freshwater.

F. ornata, E. (Pl. 43. fig. 32). Carapace hyaline; rotatory lobes six (Ehr.), five (Duj.), with long cilia, but no central proboscis; length 1-108″.

Lobes of rotatory organ thickened at the ends.

F. proboscidea, E. Carapace hyaline; rotatory organ 6-lobed, with short cilia surrounding a central proboscis; length, when extended, 1-18″. Teeth (fig. 33).

F. campanulata, Dob. Differs from *F. ornata*, Ehr., in having five lobes, and these flattened; length, when extended, 1-50″.

F. cornuta, Dob. Rotatory organ 5-lobed, one of the lobes with a narrowed, not ciliated cornu attached, arising from its outside; cilia long; length, when extended, 1-40″.

Other species.

These exquisitely beautiful animals are found adhering to aquatic plants, as *Confervæ*, *Ceratophyllum*, &c.

Bibl. Ehr. *Inf.* 407; Duj. *Inf.* 609; Dobie, *Ann. N. H.* 1849, iv. 233; Cubitt, *Mn. Mic. Jn.* 1869, ii. 143 (Pl.), and 1871, vi. 83 (new spec.); Weisse, *Sieb. & Köll. Zeitsch.* xiv. 107 (Pl.); Hudson, *Jn. Mic. Soc.* 1881, i. 4.

FLOSCULARIÆ'A.—A family of Rotatoria.

Char. Furnished with a carapace or sheath; rotatory organ single, with a flexuous, lobed or divided margin.

The cilia are often long, and only vibrate occasionally, mostly remaining rigidly extended.

Genera.

Eyes absent				1. *Tubicolaria.*
Eye single				2. *Stephanoceros.*
Eyes two	Rotatory organ	2-lobed	single	3. *Limnias.*
			aggregate	4. *Lacinularia.*
		4-lobed		5. *Melicerta.*
		5- or 6-lobed		6. *Floscularia.*

The eyes in some of the genera (*Stephanoceros* and *Floscularia*) disappear in the adult state; so that they must be looked for in the young, or even in the partly hatched ova, in which they may often be distinctly seen.

Bibl. Ehrenberg, *Infus.* p. 398.

FLUKE. See Distoma.

FLUS'TRA, Linn. (Sea-mat).—A genus of Cheilostomatous Polyzoa, family Flustridæ.

Char. Polyzoarium plant-like, foliaceous, flexible; cells in contact, alternate, in several rows, and on both sides of the polypidom; aperture transverse, semicircular or lunate, valvular and subterminal. Marine.

F. foliacea. Cells narrow at the base, rounded at the end, with scattered marginal spines. Common; about 4″ high.

F. chartacea. Cells oblong, slightly broader in the middle; lateral margins with a single minute spine.

About 1″ in height.

F. truncata. Cells linear-oblong, truncate at the end, margins without spines: 4–5″ high.

F. carbasea = *Carbasea papyrea*; *F. avicularis* = *Bugula flabellata*; *F. Murrayana* = *Bugula Murr.*; *F. membranacea*, *coriacea*, and *lineata* = *Membranipora m.*, *c.*, and *l.*

Bibl. Johnston, *Br. Zooph.* 342; Reid, *Ann. N. H.* 1845, xvi. 385; Busk, *Brit. Mus. Catal.* 47; Hincks, *Polyz.* 114.

FLUS'TRADÆ.—A family of Cheilostomatous Polyzoa.

Distinguished by the expanded, foliaceous, flexible and erect polyzoary, with its numerous contiguous cells. Two genera.

Flustra. Cells on both sides.

Carbasea. Cells on one side only.

Bibl. Busk, *Mar. Polyz.* (*Br. Mus.*) 46.

FLUSTREL'LA, Gray.—A genus of Ctenostomatous Polyzoa, of the order Infundibulata, and family Alcyonidiidæ.

Incrusting, cells radiating or alternate, the circumference with setæ; orifice rectangular.

F. hispida. Common near low-water mark upon *Fucus serratus.* Polyzoary brown, fleshy.

Bibl. Johnston, *Br. Zooph.* 363; Redfern, *Qu. Mic. Jn.* vi. 96; Hincks, *Polyz.* 504.

FLY. See Musca.

FOLLICULA'RIA = *Freia.*

FONTINA'LIS, L.—A genus of pleurocarpous Mosses.

F. antipyretica, greater water-moss; in rivulets. *F. squamata.* (Wilson, *Bryol. Brit.* 422.)

FORAMINIF'ERA.—An order in the Animal Kingdom, belonging to the Subkingdom Protozoa, and class Rhizopoda.

Char. Gelatinous, structureless, usually

microscopic marine animals, contained within calcareous shells, from orifices or pores in which fine retractile processes are emitted, by which locomotion and prehension are performed.

The shells are sometimes simple, consisting of a single cell or chamber (Unilocular, Monothalamous, or Monostegian), as in *Uniloculina, Cornuspira, Ovulites*, some *Trochamminæ, Lagena, Orbulina, Spirillina*; but the cells are usually aggregated into a compound shell (Multilocular or Polythalamous). In some they are arranged end to end in a straight row (Stichostegian), as in some *Articulinæ*, some *Lituolæ, Nodosaria, Frondicularia*. In others the single row is rolled into a spiral (Helicostegian, Nautiloid, Turbinoid, or Fusuline), as in *Peneroplis, Lituola, Cristellaria, Polystomella, Globigerina*, the *Rotalinæ, Nummulites, Fusulina*. Or the cells are arranged in two alternate rows, spirally coiled (Entomostegian), as in *Valvulina, Bulimina*. Sometimes the cells form two or three alternate rows, but not spirally coiled (Enallostegian), as in *Polymorphina, Uvigerina, Textularia*; whilst in others the cells are arranged around an (imaginary) axis, upon two or more opposing faces (Agathistegian), as in *Miliola, Chilostomella*. There are also discoidal shells with alternately concentric cells (Cyclostegian), as *Orbitolites* and *Cyclo-clypeus*. Many modifications, with dimorphic and even trimorphic modes of growth, also exist; thus *Textularia annectens* (Pl. 23. fig. 52) is helicostegian at first, enallostegian subsequently, and stichostegian at last; whilst *Bigenerina* and *Clavulina* (Pl. 23. figs. 50 & 51) have only the alternate and linear modes of growth; and *Spirolina* (Pl. 23. fig. 12) is first spiral and then linear. Between the chambers are septa, consisting of either single or double plates, perforated by one or more apertures (whence the name Foraminifera), the margins of which are sometimes more or less prolonged to form tubes, as shown in figs. 31 & 41. This tube is sometimes turned inwards (entosolenian). As the more recently formed chambers are often larger than the others, the shells are often more or less conical or pyramidal. The lines of junction of the chambers, visible externally, are called the septal lines; these are sometimes sunk, sometimes raised into ridges. Frequently the outer chambers extend laterally beyond the inner, so as to conceal them; they are then said to be embracing.

In a few of the Foraminifera the shells are composed of a number of perfectly distinct cells, each with a separate outer orifice (*Dactylopora*, Pl. 23. fig. 53).

The plan of growth offers no solid ground for the classification of these organisms; but the character of their shell-structure serves better; for there are two distinct kinds of shell:—one white, opaque, and not traversed with tubules ("porcellaneous" and "imperforate"), such as the *Miliolæ*; the other subtranslucent and tubular ("vitreous" or "hyaline," and "perforate"), such as *Nodosarina, Bulimina*, and *Nummulites*. Shells of each kind, however, are liable to become "arenaceous," by particles of sand or minute organisms being taken up in their structure, as *Quinqueloculina, Lituola, Trochammina, Valvulina, Textularia*, and *Bulimina*.

The surface of the hyaline shells presents a punctate appearance, arising from the presence of very numerous foramina, which are the outer orifices of tubules passing through the walls of the shell. The arrangement of these tubules and that of another set traversing the walls and the septa, as well as, in fact, the general structure of the shell, may be illustrated by a description of the shell of *Operculina arabica* (Pl. 24. fig. 23), in which they have been carefully traced by Mr. Carter. Here the outer surface, after the removal of a greenish epidermic layer, is seen to be covered with large and small papillæ—the former 1-2150″, the latter 1-8600″ in diameter—neither of which are present over the septa or at the margin of the shell. Each of the septa encloses within its walls two calcareous tubes, spaces, or channels, one on each side—the intraseptal channels (fig. 26); these are about 1-1900″ in diameter, and in their course give off two sets of lateral branches, terminating upon the two surfaces of the septum in which they run. The tubes communicate at each end with a network of smaller ones; one set of which ramifies in the upper, the other in the under wall or margin of each chamber; these are the marginal plexuses (fig. 24 *h*); and the former terminate upon the outer margin of the shell (*g g*). The inner wall of the chambers is pierced by innumerable tubules about 1-9000″ in diameter, which pass directly downwards from the small papillæ on the outer surface. In a vertical section of the shell, in addition to these minute tubes, seven, eight, or more parallel

horizontal lines are seen (fig. 25 *c*); these are the lines of contact of the layers composing the shell, or the lines of growth. The margin of the shell is traversed by elongated inosculating vessels, which cause the marginal portion to break up into calcareous spicula (fig. 24), 1-237″ long and 1-900″ broad. In a transverse section of the margin, more than 100 of these are seen, forming a triangular bundle or cord (fig. 25 *a*), the apex being directed towards the chamber, the base outwards forming the free rounded margin of the shell; and parallel to its side run the papillary tubes of the chamber (fig. 25 *b*).

In addition to the common foramina and the orifices of the marginal plexus, the chambers, especially those which terminate the series, are furnished with other larger orifices opening externally; these are of various forms and differently situated; sometimes they are round, numerous, and comparatively small; at others they are single and large, circular, semicircular, or lunate, &c.

The nature of the Foraminifera has been very differently viewed. They were formerly regarded as microscopic Cephalopoda, then as Bryozoa (Polyzoa), and again as intermediate between the Polypi and Echinodermata. Dujardin's view, however, is now adopted, that their structure is very simple, and that they are closely allied to the Arcellina, the body being single and composed of a simple sarcodic substance, without the distinct separation of organs, the filiform processes (pseudopodia), which issue from the various external apertures of the shell being comparable with those of *Amœba*, *Arcella*, and other members of the family.

The chambers contain a soft translucent colourless substance; and often one or more minute, round, granular bodies (sarcoblasts) are present. These appear to have been sometimes regarded as *nuclei*. If the corpuscles described by Hertwig and Schulze as *nuclei* are really such, the Foraminifera may be ranked as high as the Amœbina.

The nature of the contents of the intraseptal and marginal vessels is doubtful; Mr. Carter regards them as performing a water-vessel function comparable to that of the circulating system of the sponges (*Grantia*); whilst Williamson and Carpenter consider them to be filled with the organic substance of the body.

The shells of Foraminifera are rarely quite chitinous; some have a chitinous base with either a sandy or a calcareous coating. Mostly they are altogether composed of carbonate of lime, and therefore effervesce with a dilute acid. By carefully acting upon the recent organisms with muriatic acid, in the proportion of a drop of the strong acid to a watchglassful of water containing them, the animal is left (Pl. 23. fig. 32), retaining the general form of the shell, which it has moulded upon itself.

In the "porcellaneous" group the shell-matter covers each segment of sarcode tent-wise, the edges of the new chambers resting on the outside of the older part of the shell. In the "hyaline" group each segment is, in many cases, fully enwrapped with shell, except at the septal orifice, through which the stolon connects the new and old segments. Besides this tubuliferous shell-layer, many of the hyaline Foraminifera lay down other coats, by the investing sarcode, before new segments are set off; and these supplementary layers not only form ridges and tubercles, but also the "intermediate skeleton," in which vessels or canals, for the sarcode passing outwards, are more or less prevalent, constituting the "Canal-system."

Recent Foraminifera can be procured by dredging, or sometimes from the sand of the sea-shore. They often form white lines or bands, between tide-marks. To separate them, the sand should be washed in fresh water, dried, and spread upon a piece of black paper, or the black disk (INTROD. p. xxvi), and examined as an opaque object; when the shells, easily distinguished by their forms, may be picked out by means of a mounted bristle.

Or the dried sand may be stirred up with water and allowed to settle; the sandy particles will then subside, and the shells, from their chambers being filled with air, may be skimmed off the surface; or they may be poured off through muslin, with the disturbed water, before all the sediment has had time to settle.

In the fossil state, the Foraminifera abound in Chalk, from which they may be obtained in the manner directed under CHALK; in fact this substance constitutes one of the best sources of them for examination. In other calcareous rocks or limestones they are also extremely numerous. Thus in the stones of which the buildings in Paris are constructed, the shells of the

Miliolidæ are so abundant, that this city may be said to be built of them.

The Nummulites or coin-stones which form mountains in the Mediterranean and North-Indian regions, and of which the pyramids of Egypt are principally composed, are Foraminifera (Pl. 24. figs. 21, 22).

Many clays, such as those of the Lias, the Oolitic and Cretaceous series, and London Tertiaries, those of Prussia, Belgium, Malaga, San Domingo, &c., and many shelly sands of Tertiary age in Suffolk, Italy, Germany, France, New Zealand, Australia, and elsewhere, also yield Foraminifera by careful washing.

See the articles CHALK and RHIZOPODA.

Synoptical List of the Genera and Subgenera of Foraminifera.

(The subgenera are placed in parentheses.)

Division A. **IMPERFORATA.**

Subdivision 1. CHITINACEA.

GROUP I. Test chitinous, imperforate.

Fam. 1. **Gromidæ.**

Gromia, Dujardin; *Lieberkuehnia*, Claparède; *Shepheardella*, Siddall.

Subdivision 2. CALCAREA (PORCELLANEA).

GROUP II. Test calcareous, imperforate, porcellaneous, and sometimes sandy; occasionally chitinous and sandy.

Fam. 2. **Miliolidæ.**

a. MILIOLINA.—*Bathysiphon*, G. O. Sars; *Squamulina*, Schultze; *Nubecularia*, Defrance; *Miliola*, Lamarck, Plate 23. fig. 1 (= *Miliolina*, Williamson); (*Uniloculina*, d'Orb., Pl. 23. fig. 2; *Biloculina*, d'Orb., Pl. 23. fig. 3; *Spirolocuiina*, d'Orb., Pl. 23. fig. 7; *Triloculina*, d'Orb., Pl. 23. fig. 4; *Quinqueloculina*, d'Orb., Pl. 23. figs. 5, 6; *Cruciloculina*, d'Orb.); *Cornuspira*, Schultze, Pl. 23. fig. 13 (*Ophthalmidium*, Kübler); *Nummuloculina*, Steinmann; *Hauerina*, d'Orb., Pl. 23. fig. 8; *Vertebralina*, d'Orb., Pl. 23. fig. 9 (*Articulina*, d'Orb., Pl. 23. fig. 9); *Fabularia*, Defr.

b. ORBITOLITINA.—*Peneroplis*, de Montfort, Pl. 23. fig. 11. (*Dendritina*, d'Orb.; *Spirolina*, Lamarck, Pl. 23. fig. 12.) *Orbiculina*, Lam., Pl. 23. fig. 19; *Orbitolites*, Lam., Pl. 23. fig. 17; *Alveolina*, d'Orb., Pl. 23. figs. 15, 16.

c. ? DACTYLOPORINA.—*Ovulites*, Lam.; *Haploporella*, Gümbel (= *Dactylina*, Zbor.?), Pl. 23. fig. 53; *Dactyloporella*, Gümb. (= *Dactylopora*, Lamarck, in parte), Pl. 23. fig. 54; *Thyrsoporella*, Gümb.; *Gyroporella*, Gümb.; *Cylindrella*, Gümb.; *Uteria*, Michelin; *Acicularia*, d'Archiac.

Subdivision 3. ARENACEA.

GROUP III. Test calcareous and arenaceous.

Fam. 3. **Astrorhizidæ.**

Psammosphæra, Schultze; *Sorosphæra*, Brady; *Saccammina*, M. Sars; *Pilulina*, Carpenter; *Storthosphæra*, Schulze; *Technitella*, Norman; *Pelosina*, Brady; *Aschemonella*, Br.; *Astrorhiza*, Sandahl; *Dendrophrya*, Str. Wright; *Rhabdammina*, M. Sars; *Jaculella*, Br.; *Hyperammina*, Br.; *Psammatodendron*, Norman (MS.); *Sagenella*, Br.; *Botellina*, Carpenter; *Marsipella*, Norman; *Haliphysema*, Bowerbank; *Polyphragma*, Reuss.

Fam. 4. **Lituolidæ.**

(These comprise sandy isomorphs of the simpler types of the *Hyalina*, such as *Lagena*, *Nodosaria*, *Globigerina*, *Rotalia*, *Nonionina*, &c.)

Lituola, Lam., Pl. 23. fig. 23 (*Reophax*, de Montfort; *Haplophragmium*, Reuss; *Haplostiche*, Rss.; *Placopsilina*, d'Orb.; *Bdelloidina*, Carter); *Trochammina*, Parker & Jones, Pl. 23. fig. 14 (*Hormosina*, Brady; *Ammodiscus*, Rss.; *Webbina*, d'Orb., Pl. 23. fig. 21); *Nodosinella*, Br.; *Involutina*, Terquem; *Endothyra*, Phillips; *Stacheia*, Br.; *Thurammina*, Br.; *Hippocrepina*, Parker; *Cyclammina*, Br.

Fam. 5. **Parkeridæ.**

Parkeria, Carpenter; *Loftusia*, Brady.

Division B. **PERFORATA** (**Vitrea** vel **Hyalina**).

GROUP IV. Tests of many of the larger forms arenaceous, with more or less of a calcareous perforate basis; smaller forms hyaline and perforate.

Fam. 6. **Textularidæ.**

a. TEXTULARINA.—*Textularia*, Defrance, Pl. 23. figs. 47, 52 (*Vulvulina*, d'Orb., Pl. 23. fig. 49; *Bigenerina*, d'Orb., Pl. 23. fig. 50; *Venilina*, Gumbel; *Pavonina*

d'Orb.; *Spiroplecta*, Ehrenberg; *Cuneolina*, d'Orb.); *Verneuilina*, d'Orb. (*Gaudryina*, d'Orb., Pl. 23. fig. 48; *Heterostomella*, Rss.; *Chrysalidina*, d'Orb.; *Tritaxia*, Rss.); *Valvulina*, d'Orb., Pl. 23. fig. 20 (*Clavulina*, d'Orb., Pl. 23. fig. 51).

b. Buliminina.—*Bulimina*, d'Orb., Pl. 23. fig. 46 (*Virgulina*, d'Orb.; *Bolivina*, d'Orb.; *Bifarina*, P. & J.; *Robertina*, d'Orb.; *Pleurostomella*, Reuss).

c. Cassidulinina.—*Cassidulina*, d'Orb., Pl. 23. fig. 45; *Ehrenbergina*, Reuss.

Group V. Test calcareous, finely perforate.

Fam. 7. **Chilostomellidæ.**

Chilostomella, Reuss; *Allomorphina*, Reuss; *Ellipsoidina*, Seguenza.

Fam. 8. **Lagenidæ.**

a. Lagenina.—*Lagena*, Walker and Jacob, Pl. 23. figs. 22, 24–27 (*Entosolenia*, Ehr., Pl. 23. fig. 23; *Fissurina*, Reuss); *Ramulina*, Jones. *Nodosarina*:—*Nodosaria*, Lam., Pl. 23. fig. 28 (*Glandulina*, d'Orb.; *Dentalina*, d'Orb., Pl. 23. fig. 33; *Lingulina*, d'Orb.); *Orthocerina*, d'Orb., = *Rhabdogonium*, Rss., Pl. 23. fig. 36; *Frondicularia*, Defr., Pl. 23. fig. 39 (*Amphimorphina*, Neugeb.); *Vaginulina*, d'Orb., Pl. 23. fig. 35 (*Rimulina*, d'Orb.); *Marginulina*, d'Orb., Pl. 23. figs. 30–32; *Cristellaria*, Lam., Pl. 23. figs. 34, 37 (*Planularia*, Defr.); *Flabellina*, d'Orb., Pl. 23. fig. 38.

b. Polymorphinina. — *Polymorphina*, d'Orb., Pl. 23. figs. 40–43 (*Dimorphina*, d'Orb.); *Uvigerina*, d'Orb., Pl. 23. fig. 44 (*Sagrina*, d'Orb.).

Group VI. Test calcareous, generally with coarse perforations; without canal-system.

Fam. 9. **Globigerinidæ.**

Globigerina, d'Orb., Pl. 24. figs. 2, 3 (*Orbulina*, d'Orb., Pl. 24. fig. 1); *Pullenia*, Parker and Jones; *Sphæroidina*, d'Orb. (Pl. 24. fig. 4); *Candeina*, d'Orb.

Group VII. Test calcareous, coarsely perforate; some with double chamber-walls and interseptal canals.

Fam. 10. **Rotalidæ.**

Spirillina, Ehrenb. (Pl. 24. fig. 5); *Patellina*, Williamson (Pl. 24. fig. 8); *Discorbina*, P. & J. (Pl. 24. fig. 7); *Planorbulina*, d'Orb., Pl. 24. figs. 6, 10, 12 (*Truncatulina*, d'Orb., Pl. 24. fig. 9; *Anomalina*, d'Orb.); *Rupertia*, Wallich; *Carpenteria*, Gray; *Polytrema*, Risso; *Tinoporus*, Carpenter (= *Gypsina*, Carter); *Cymbalopora*, von Hagenow (Pl. 24. fig. 17); *Thalamopora*, Rss.; *Pulvinulina*, P. & J. (Pl. 24. figs. 11, 16); *Rotalia*, Lamarck (Pl. 24. figs. 13, 14); *Calcarina*, d'Orb.

Group VIII. Test calcareous, very finely tubulated; all the higher forms with a system of interseptal canals.

Fam. 11. **Nummulitidæ.**

a. Polystomellina.—*Nonionina*, d'Orb. (Pl. 24. fig. 18); *Polystomella*, Lam. (Pl. 23. fig. 55, Pl. 24. figs. 19, 20).

b. Nummulitina.—*Archædiscus*, Brady; *Amphistegina*, d'Orb. (Pl. 24. fig. 28); *Fusulina*, Fischer (Pl. 24. fig. 15); *Eozoön*, Dawson; *Cycloclypeus*, Carpenter; *Heterostegina*, d'Orb.; *Operculina*, d'Orb. (Pl. 24. figs. 23–26); *Nummulites*, Lam., Pl. 24. figs. 21, 22 (*Assilina*, d'Orb.).

Unplaced groups:—

Group IX. **Testamœbiformia**, Carter. Lobose forms.

a. Test calcareous.—*Holocladia* and *Cysteodictyina*, Carter.

b. Test chitinous.—*Cerastestina*, Carter.

Group X. **Syringosphæridæ**, Duncan. Test calcareous, with radiating groups of tubules.

Syringosphæria and *Stoliczkaria*, Duncan.

Group XI. **Receptaculitidæ**, Gümbel. Test calcareous, consisting of an inner and an outer floor of plates, connected by the tubes of an anastomosing canal-system.

Receptaculites, Defr.; *Ischadites*, König; *Tetragonis*, Eichwald; *Sphæronites*, Hisinger; *Sphærospongia*, Salter.

Bibl. D'Orbigny, *Dict. Sc. Nat.* 1826, vii.; *Mém. Soc. Géol. France*, iv.; *Dict. d'Hist. Nat.* 1845, v.; *Foram. foss. Vien.* 1846; Ehrenb. *Mikrog.* 1854; id. *Abh. Ak. Berlin*, 1838, 1839, 1841, 1847, &c.; Weaver, *Ann. N. H.* 1841, vii. 296, 374; Dujardin, *Ann. Sc. Nat.* 1835, iv. & v.; Clark, *Ann. N. H.* 1849, iii. 388, 1850, v. 161; Williamson, *Tr. Micr. Soc.* ii., and *Recent Foraminif.* (*Ray Soc.*); Carpenter, *Tr. Geol. Soc.* 1849; *Microscope*; *Phil. Tr.* 1856, 59, 60, 69;

Introd. Foram.; Carter, *Ann. N. H.* 1852, x., 1853, xi., 1854, xiv., &c.; Schultze, *Organism. Polythal.*; *Müller's Archiv*, 1856 (*Q. J. Micr. Soc.* v. 220); *Wiegmann's Archiv*, 1860 (*Ann. N. H.* ser. 3, vii. 306); Parker, Jones, and Brady, *Ann. N. H.* 2. xix.; 3. iii., iv., vi., viii., xi., xii., xv., xvi.; 4. iv., vi., viii., ix., x.; *Q. J. Geol. Soc.* xvi. 292, 452; xxviii. 103; *Phil. Trans.* 1865; *Tr. Linn. Soc.* 1864 and 1870; *Monogr. Crag For.* (*Pal. Soc.*) 1866; Reuss, *Verst. Böhm. Kreid.* 1845-46; *Haiding. Abhandl.* iv.; *Denksch. Akad. Wien*, i., vii., xxiii., xxv.; *Sitz. Ak. Wien*, passim; *Zeitsch. deut. geol. Ges.* iii., vii., &c.; Gümbel, *Abhandl. bayr. Ak.* x. &c.; also the memoirs of Soldani, Römer, Von Hagenow, Philippi, Reuss, Czjzek, Alth, Bornemann, Egger, Neugeboren, Karrer, &c.

Since 1875 the following have added to the bibliography of the subject:—

A. M. Norman, J. D. Siddall, J. H. Carter, W. J. Sollas, J. F. Blake, E. Vanden Broeck, Joseph Wright, H. B. Brady, A. W. Waters, Ph. de la Harpe, W. K. Parker, T. R. Jones, G. Stache, F. Karrer, C. W. Gümbel, J. W. Dawson, C. Schwager, M. von Hantken, G. Steinmann, G. C. Wallich, P. M. Duncan, G. Terrigi, C. Möbius, J. Seguenza, &c.

FOR'DA, Heyden. See APHIDÆ, p. 63.

FORFIC'ULA, Linn. *F. auricularis* is the common earwig.

FORMIC ACID, or acid of ants.—This acid occurs in ants, especially the red ant, *Formica rufa*; in the stinging hairs of some insects, as of the procession-caterpillar (*Bombyx processionea*); and in the poisonous secretion of the stings of insects; perhaps also in the stinging organs of the Acalephæ and Polypes. In the higher animals it is a frequent product of the oxidation of organic substances, and is also found in the juice of flesh, in the urine, in vomited liquids, and in the blood; also in the stinging hairs of the nettle &c.

FOSSIL INFUSORIA.—The fossil valves of the Diatomaceæ were formerly so called. See DIATOMACEÆ.

FOSSIL WOOD.—This occurs in very different conditions:—as, for example, converted into lignite, and the modifications of coal; or with the vegetable substance almost entirely removed and replaced by silex, preserving all the organic forms of the tissues. The mode of examining and mounting COAL, &c., is given under that article. Silicified woods which have been completely infiltrated and solidified require to be cut into thin sections and polished by the lapidary; the friable kinds, where the infiltration has merely filled the cavities of the cells and vessels, may be split with a knife and mounted in balsam. Examples are given in Pl. 25. figs. 29–33. Pl. 48. fig. 32, exhibits concretions of silica imitating structure. The stems of Palms and Dicotyledonous trees are met with completely converted into siliceous blocks, sections of which exhibit all the minutiæ of the structure.

FOSSOMBRO'NIA, Raddi.—A genus of Pelliæ (Hepaticæ), nearly allied in the character of its vegetative structure to the Jungermannieæ, having large, squarish, irregularly waved leaves. The stout stems are procumbent, and set with purple radicles all along the underside. The fruit-stalk arises from the underside of the stem, and turns back; the perichæte is very large; and the capsule bursts irregularly into four slender erose valves. *F. pusilla* is the *Jungermannia pusilla* of the British Flora; found chiefly on clay banks.

BIBL. Hook. *Brit. Jungerm.* pl. 69, *Brit. Flor.* ii. pt. 2. 117; Endlicher, *Gen. Plant.* suppl. i. no. 472–7.

FOVIL'LA.—The name applied to the liquid granular matter filling the pollen-cell and passing into the pollen-tube of Flowering Plants. The minute granules, which are of various but altogether indefinite sizes, exhibit an active quivering motion—the molecular motion, as it is called—which is displayed in the same way by all finely-divided solid substances, living or dead, and is apparently dependent on purely physical causes. They appear to consist of starch-grains, minute globules of oil, and granules of protoplasm probably composed of proteine compounds. These granules are exceedingly transparent in many kinds of pollen when fresh, from their refracting-power being nearly equal to that of the fluid surrounding them. They may be made visible by adding water.

FRAGILA'RIA, Lyngb.—A genus of Diatomaceæ (Cohort Fragilarieæ).

Char. Frustules (in front view) linear, symmetrical, united into straight or twisted flat filaments; valves lanceolate, oblong or linear.

Differs from *Diatoma* in the filaments not becoming separated into zigzag chains. Transverse striæ only visible under oblique or "stopped" illumination.

Kützing enumerates sixteen species, of

which ten are doubtful. Rabenhorst admits 9 species, with numerous varieties.

F. capucina, K. (*F. rhabdosoma*, E., Pl. 16. fig. 33). Frustules linear in front view; valves narrowly and acutely lanceolate; breadth of filament 1-700″. Freshwater. Common in pools, &c.

β. Valves attenuate towards the obtuse ends.

F. virescens, Ralfs (*F. pectinalis*, Ehr.). Frustules in front view linear, rectangular or cuneate; valves obtuse at the contracted and produced ends. Freshwater. Endochrome green.

β. Valves cohering by the angles only.

F. striatula. Valves linear, narrowed towards the very obtuse ends. Marine.

Bibl. Kützing, *Bacill.* 45; id. *Sp. Alg.* 14; Ralfs, *Ann. N. H.* 1843, xii. 106; Smith, *Brit. Diat.* ii. 21; Rabenhorst, *Flor. Alg.* i. 118.

FREDERICEL'LA, Gervais.—A genus of Polyzoa, of the order Hippocrepia, and family Plumatellidæ.

Char. Polypidom fixed, coriaceous, tubular, branched; polypes protruding from the ends of the branches; tentacular disk nearly circular; tentacles about twenty-four, arranged on the margin of the disk in a single series, and invested at their origin by a membrane. Freshwater.

F. sultana. Polype-cells erect, cylindrical. Height of zoary about 2″; tufted, shrubby; stem dichotomously branched. Eggs bean-shaped, smooth.

Bibl. Allman, *Freshw. Polyzoa* (*Ray Soc.*), 110; Johnston, *Br. Zooph.* 405.

FREI'A, Cl. & L.—A genus of Infusoria, of the family Bursarina.

Char. Those of *Stentor*, with the buccal spire borne by an anterior membranous bilobed expansion.

3 species: marine.

F. elegans (Pl. 52. fig. 1.).

Bibl. Clap. and Lachm. *Infus.* 217; St. Wright, *Qu. Mic. Jn.* 1862, 217.

FREY'A. See Freia.

FROG.—The common frog (*Rana temporaria*) affords a means of studying several interesting points of structure. Thus, by gently scraping the back of the roof of the mouth with the handle of a scalpel, ciliated epithelium (Pl. 49. fig. 13) may be obtained, and the ciliary movement studied. The circulation in the web of the foot, and the phenomena of inflammation may be observed, by enclosing a frog in a wet bag, leaving one leg projecting. The bag containing the frog may then be placed upon a plate of wood, with a circular aperture at one end, over which the foot is to be extended by tying the toes with silk or cotton threads to little tacks or nails driven into the wooden plate. Metal "frog-plates" are sold for the purpose. Sections of the kidney of the frog, made with a Valentin's knife, will show the ciliated epithelium of the necks of the urinary tubules. The circulation of the blood in the lungs and the mesentery may be examined; but the animal should be rendered insensible by chloroform before the experiment.

The ova of the frog (frogs' spawn) have formed the subject of some of our most interesting experiments on impregnation and development. The larvæ (tadpoles) exhibit well the circulation in the gills, tail, and more transparent parts, and afford easily obtained materials for the study of the development of the tissues. The chorda dorsalis is well seen in a young tadpole. The frog and tadpole, however, are inferior in most respects to the Triton and its larvæ for exhibiting these phenomena.

The injected organs of the frog afford most interesting and beautiful preparations, especially the lungs, kidneys, skin, tongue, and web of the foot. The injection should be thrown in at the heart, and the slightest possible force used. The simplest method of killing a frog without injury, is to immerse and retain it in warm water.

The muscles of the frog often contain a nematoid parasite (*Myoryktes Weissmanni*).

FRONDICULA'RIA, Defr.—This pseudo-genus comprises flat stichostegian *Nodosarina*, which have geniculate or chevron chambers. They are the extremely compressed and dilated forms of the group, having the quasi-genus *Lingulina* to connect them with the cylindrical *Nodosariæ*. In *Frondicularia* the shell is equilateral; narrow-oblong, rhomboidal, or ovate; greatly compressed; chambers in a straight row, depressed, each forming two sides of a triangle, with the angle sometimes prolonged; septal lines often raised as ridges; intermediate spaces sometimes striate; first chamber oval; aperture round, on the upper angle.

Recent in the Atlantic. Fossil in the Tertiaries of Italy, Spain, and West Indies; and abundant in the Chalk, Gault, Lias, and other fossil clays. *Fr. spathulata* (Pl. 23. fig. 39) shows the early portion of a speci-

men from the Chalk, closely allied to the typical *Fr. complanata*, Defr.

Bibl. D'Orbigny, *For. Foss.* 57; Williamson, *Rec. For.* 23; Morris, *Br. Foss.* 35; Reuss, *Böhm. Kreid.*; Carpenter, *Introd. For.* 160, 164.

FRONTO'NIA, Ehr.—A genus of Infusoria, of the family Bursarina (Cl. & L.).

Char. Resembles *Ophryoglena*, except in the absence of the watch-glass organ.

Most of the species of Dujardin's genus *Panophrys* belong here.

F. leucas (*Bursaria l.*, Ehr.). Parenchyma armed with trichocysts; buccal fossa oval, pointed behind; a single contractile vesicle. Freshwater.

Bibl. Ehrenberg, *Inf.* 329; Clap. and Lachm. *Infus.* 259.

FRULLA'NIA, Raddi.—A genus of Jungermannieæ (Hepaticæ), containing three British species, the *Jungermannia Hutchinsiæ*, *dilatata*, and *Tamarisci* of Hooker's British Flora. *F. dilatata* is very common, creeping on the bark of trees, its dark brown dry foliage appearing like minute spreading

Fig. 251.

Frullania Tamarisci.

Portion of a stem, with branches bearing the perichætes from which the sporanges emerge.

Magn. 5 diams.

blotches; the almost sessile capsules are somewhat inconspicuous, but are distinguished by their whitish colour. The valves of the capsule and the elaters afford beautiful microscopic objects, illustrative of the spiral structures in cells. *F. Tamarisci* (fig. 251) has longer and more regularly pinnate stems, forming large lax tufts on the ground and low bushes, chiefly in Subalpine countries.

Bibl. Hook. *Brit. Jungerman.* pls. 1, 5, 6; *Brit. Flora*, ii. pt. 1. 128; Endlicher, *Gen. Plant.* Suppl. i. No. 472–10.

FRUSTU'LIA, Ag.—A genus of Diatomaceæ.

Char. Frustules naviculoid, free or irregularly scattered through an amorphous gelatinous mass; valves elliptic-lanceolate, without central and terminal nodules; longitudinal line interrupted in the middle. Freshwater.

F. salina, Ehr. Frustules in front view very narrowly linear, rounded at the ends; valves suddenly acute at the ends; transverse striæ evident; gelatinous envelope continuous; length of frustules 1-2200 to 1-864″. Found in a saline spring.

This organism is of particular interest, as having formed the subject of Schmidt's ultimate analysis, in which he determined the presence of cellulose. (Diatomaceæ, p. 249.)

F. membranacea, nobis (Pl. 50. fig. 6). Frustules in front view linear, very slightly narrowed towards the ends; valves lanceolate, constricted near the obtuse ends; length of frustules 1-1250″.

Found abundantly forming a thin stratum or film upon the sides of a glass jar containing water-plants.

F. saxonica, Rab. (Pl. 19. fig. 17). Frustules in front view linear, rounded at the ends; valves elliptical, somewhat acute.

Forms dirty olive-brown, gelatinous, tremulous masses, contained in small pits in rocks.

This is sometimes used as a test-object. It is regarded by Dallinger and others as the same as *Navicula rhomboides* and *crassinervis*.

Rabenhorst describes 5 species; one fossil.

Bibl. Ehrenb. *Infus.* 232; Kützing, *Bacill.* 109; id. *Sp. Alg.* 96; Rabenhorst, *Fl. Alg.* i. 227; Hickie, *M. M. Jn.* 1876, xv. 122; Stodder, *ibid.* 253; Dallinger, *ibid.* 1877, xvii. 1, 173.

FUCA'CEÆ.—A family of Fucoideæ. Olive-coloured inarticulate sea-weeds, whose reproductive organs are borne in stalked sacs upon the walls of spherical cavities excavated in the substance of the frond. *Fructification*, *sporanges* or spore-sacs and *antheridia*. The spores of *Fucus* divide into two, four, or eight within the sac; those of the other genera remain undivided. The antheridia are filled with spermatozoids or antherozoids, which in *Fucus* have been seen to fertilize the spores. See Fucus.

British Genera.

* *Air-vessels stalked.*

Sargassum. *Branches* bearing ribbed leaves; air-vessels simple.

Halidrys. *Frond* linear, pinnate, leafless; air-vessels divided into several cells by transverse partitions.

** *Air-vessels immersed in the substance of the frond or absent.*

Cystoseira. *Root* scutate. *Frond* much branched, bushy. *Receptacles* cellular.

Pycnophycus. *Root* branching. *Frond* cylindrical. *Receptacles* cellular.

Fucus. *Root* scutate. *Frond* dichotomous. *Receptacles* filled with mucus, traversed by jointed threads.

Himanthalia. *Root* scutate. *Frond* cup-shaped. *Receptacles* (frond-like) very long, strap-shaped, dichotomously branched.

FUCOI'DEÆ, or MELANOSPOREÆ.—An order of Algæ, deriving their ordinary name from the *Fucus* or *Wrack*, one of the most common genera of the family. They present many remarkable points of difference from the red sea-weeds in their higher forms, while the lowest forms approach the simpler genera of that order and the higher forms of the Confervoideæ. The Fucoids are exclusively marine, and are at once distinguished by their olive or dark-brown colour; and although some of the larger kinds grow in deep water, the majority are met with on rocks between high- and low-water mark, where they are exposed to the atmosphere at each efflux of the sea: those which are occasionally drawn up from deep water prove that this exposure is necessary for healthy growth, by their weak structure and the absence of fructification. Some of them are also provided with air-bladders, which maintain them floating or erect and with at least their upper lobes little beneath the surface of the water. These air-bladders are very well seen in our common Bladder-wrack (*Fucus vesiculosus*, fig. 252); and still more so in the celebrated Gulf-weed (*Sargassum bacciferum*), where the stalked berry-like bladders are the most striking feature of the plant.

All the larger kinds grow on rocks, to which they are attached by a root-like structure, of somewhat conical form, cleaving, like the 'sucker' with which school-boys lift stones, to the rock; in many this cone is solid, and composed of tough cellular tissue; in others, especially the Laminariaceæ, it is composed of a number of stout, superjacent, branched cords, growing out of the frond one above another, and attaching themselves to the rock, like the roots of a Tree-fern or a Palm. Some (*Pycnophycus*) spring from a creeping stem-like portion, spreading in a netted mass over the rocks,—while many of the smaller are parasitical or, more properly, epiphytic, growing on the fronds of the larger kinds, to which they attach themselves by minute 'sucker'-like disks. Some appear to be true parasites (*Elachisteæ* and *Myrionemata*). Several are of minute size, but very few strictly microscopic. Almost all present three regions, resembling respectively the root, stem, and leaf or leaves of the higher plants, although they are not ordinarily regarded as the morphological analogues of them. In a few cases the frond is a shapeless mass or crust, lying close to the surface of the rocks. None become calcified like the Corallines.

The *fructification* of these plants is still in a somewhat obscure condition as regards the order in general; for great apparent diversities occur in the physiological phenomena presented by what at first appear like identical structures. We have here, as in the *Florideæ*, three distinct forms of reproductive structure, known respectively as:—1, *zoospores*; 2, *spores*; and 3, *spermatozoids*.

1. The *zoospores* are the reproductive bodies most frequently met with; and in the lower forms the arrangements are not very different from those in the filamentous Confervoids. In ECTOCARPUS, where the frond is composed of jointed cellular filaments, the cells at the ends of the branches, or other articulations, become enlarged and filled with granular matter which is ultimately converted into *zoospores*. These enlarged cells are called by Thuret *sporanges*, and are commonly described as *spores* in algological works; but they burst and discharge the numerous microscopic *zoospores*, which are pear-shaped, with a clear, beak-like, narrow end, of olive colour, and have two cilia, not arising from the beak, but from a reddish point on the coloured portion; one cilium is longer than the other, and directed forwards; the other is short, and trails behind like a kind of rudder. Their movements are very active; and they seek the light. When they germinate, they become immovable and spherical, acquire a membranous coat, and emit a tubular prolongation, which soon becomes divided by cross septa, and is developed into a new

frond. In some cases the sporanges are multilocular (*trichosporanges*), consisting of very slender, and usually rather short, jointed filaments, in each joint (cell) of which a single *zoospore* is produced. These occur in considerable number, occupying the same place as the unilocular kind, which they sometimes accompany; and the two forms appear to pass one into the other. The zoospores are perfectly similar, except that those produced singly in the filaments are not so large as those developed in large numbers in the large, ovate, unilocular sporanges.

The two forms of sporange producing zoospores have been found in the Myrionemaceæ, Chordariaceæ, Sporochnaceæ, Punctariaceæ, and Dictyosiphonaceæ; in *Chorda lomentaria* only the multilocular, and in the other Laminariaceæ only the unilocular, have been seen at present.

The Cutleriaceæ present the remarkable phenomenon of the occurrence of sporanges containing zoospores together with antheridia analogous to those of the FUCACEÆ. (See CUTLERIA.)

Those Fucoideæ in which the reproduction is effected by zoospores only, form Thuret's group of Phæosporeæ.

2. The *spores* occur in the Dictyotaceæ and the Fucaceæ, as large granular bodies of ovate form, enclosed in a sporange or oogonium, and clothed besides by a gelatinous coat called the *epispore*; these large spores are always devoid of power of motion. In some cases they are simple reproductive spores; in others they subdivide, after escaping from the perispore, into two, four, or eight sporules, each capable of germination. (See FUCUS, and figs. 253, 256.) In the Dictyotaceæ these spores are collected into definite groups (*sori*) on the surface of the frond. In the Fucaceæ the spores are found in spherical cavities immersed in the substance of the frond, sometimes occurring in all parts, sometimes collected in special regions. These cavities communicate with the external surface by pores, and are usually perceptible from the swollen slimy appearance where they open. Where no general receptacles exist, the little spherical chambers are excavated in the frond; where these do occur, as in *Fucus*, the spherical chambers are attached to the inside of their walls, one beneath each external pore. These chambers, called by some *scaphidia*, by others *conceptacles*, contain *spores* or *antheridia*, or both. The spores occur in sacs consisting of a cell (*perispore*) springing from the wall of the chamber. (See FUCUS.)

3. *Spermatozoids* have been met with, as well as zoospores, in the Cutleriaceæ. The *spermatozoids* or *antherozoids* exactly resemble those of *Halidrys* and *Pycnophycus*, described below.

In *Dictyota* the spermatozoids occur on separate plants, in antheridia grouped in sori like the spore-fruit.

In the Fucaceæ the *spermatozoids* or antherozoids occur with the *spores* above described. In *Fucus canaliculatus* (*Pelvetia*, Dcne. and Thuret) and *F. platycarpus* (Thuret) the antheridia are found, in company with the spores, in the conceptacles; in the other species of *Fucus* the two kinds of organs are never met with together in the same conceptacle; in *Himanthalia lorea* they are on distinct plants, in *Halidrys siliquosa* intermingled, and in *Pycnophycus tuberculatus* in the same chamber but not mixed. The antheridia of these plants consist of transparent ovoid sacs, inserted in great number on the branched hairs (*paranemata*) (fig. 254) clothing the inside of the fruit-chambers or *scaphidia*. In some genera they have a double coat, in others only one; when two exist, the inner is expelled as a sac on the rupture of the antheridium; when only one exists, the spermatozoids are expelled individually and freely from the single coat, which always remains attached upon its support. The spermatozoids or antherozoids found in these sacs are little hyaline globules, each enclosing a granule of grey colour in *Fucus canaliculatus*, red-orange in all other species of *Fucus* and other genera. They bear two locomotive cilia, very slender, and of unequal length. The form of the corpuscles and the arrangement of the cilia differ in different genera. In all the species of *Fucus* the spermatozoids are of the shape of little bottles, the neck of which, always foremost in the movement, bears the shortest cilium; the longer arises from the coloured granule, and trails behind. In *Halidrys*, *Pycnophycus*, and *Cystoseira*, the corpuscle is oval or spherical in one dimension, and compressed, sometimes a little convex, in the other; both the cilia are inserted on the red granule, and during the locomotion the corpuscle turns upon its own axis, with the longer cilium in advance, vibrating with rapidity, while the shorter is motionless. In *Himanthalia* the antheridia have a double coat; the

form of the antherozoids is not clearly made out. The antherozoids of the Fucaceæ have been shown by Thuret, their discoverer, to be analogous to the spermatozoids of the higher Cryptogamia, and to perform a fertilizing function—not to reproduce the plant like the zoospores of the other families; and the multiplication appears to be effected solely by the large olive-coloured spores. (See FUCACEÆ.)

Synopsis of the Families.

FUCACEÆ. *Frond* leathery or membranous, cellular. *Fructification: spores* and *antheridia* contained together or separately in spherical cavities imbedded in the frond.

DICTYOTACEÆ. *Frond* cellular, flat, compact. *Fructification: spores, antheridia* (and *tetraspores*?) arranged in definite spots or lines (*sori*) on the surface.

CUTLERIACEÆ. *Frond* cellular, compact, ribless. *Fructification*: dot-like scattered collections of *sporanges* divided into eight compartments; and *antheridia* consisting of chambered filaments in groups of curved jointed hairs.

ECTOCARPACEÆ. *Frond* filiform, jointed. *Fructification: unilocular sporanges*, ovate sacs developed at the ends or intermediate joints of the filaments; and *multilocular sporanges*, consisting of minute jointed filaments found in similar situations. *Antheridia* with spermatozoids have been found in *Sphacelaria*.

LAMINARIACEÆ. *Frond* leathery or gelatinous, cellular. *Fructification: unilocular sporanges* in indefinite cloud-like patches, or covering the whole surface of the frond; or *multilocular sporanges* clothing the whole surface of the frond like an epidermis.

DICTYOSIPHONACEÆ. *Frond* cylindrical, branched, of filamentous structure. *Fructification*: ovoid *sporanges* imbedded lengthways in the substance of the frond, opening by a pore on the surface.

PUNCTARIACEÆ. *Frond* cylindrical or flat, unbranched, cellular. *Fructification:* ovate *sporanges* in groups on the surface, intermixed with clavate filaments (*paraphyses*).

SPOROCHNACEÆ. *Frond* leathery or membranous, cellular, branched. *Fructification: unilocular* or *multilocular sporanges* attached to external jointed filaments, free or collected in knob-like masses.

CHORDARIACEÆ. *Frond* cartilaginous or gelatinous, composed of horizontal and vertical jointed filaments interlaced. *Fructification: unilocular sporanges* springing from the base of the vertical filaments forming the epidermis of the frond; and *multilocular sporanges* developed later from the filaments surrounding the former.

MYRIONEMACEÆ. *Frond* tuber-shaped, crustaceous, or spreading as a crust, of filamentous structure. *Fructification: unilocular* and *multilocular sporanges* attached to the superficial filaments, and concealed among them.

BIBL. See that of the Families.

FU'CUS, Linn.—A genus of Fucaceæ (Fucoid Algæ), including some of the commonest and most abundant of our olive-coloured sea-weeds, growing upon rocks and stones between tide-marks, their large fronds waving in the water at high tide, and lying matted together over the rocks when the tide is out; continually cast ashore in quantities after rough weather. *F. vesiculosus*, the common *bladder-wrack*, is familiar to every one who has visited a sea-coast. Decaisne and Thuret divide the genus into three: *Pelvetia* (*F. canaliculatus*), *Ozothallia* (*F. nodosus*), and *Fucus* proper, including *F. serratus, vesiculosus*, and *ceranoides*.

In *F. nodosus* and *F. Mackaii* the receptacles are lateral and stalked; but in all the rest they are terminal and continuous with the frond (fig. 252), forming oval thickened

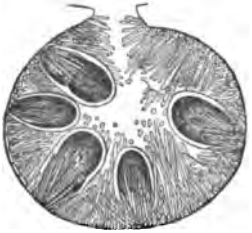
Fig. 252.

End of a branch of F. vesiculosus, bearing two terminal receptacles.
Half the nat. size.

clubs, on which, by the naked eye, may be distinguished a number of spots or pores. These are the orifices of the conceptacles, which are globular cases immersed in the substance of the receptacle, and communicating with the outer surface by a pore (fig. 253). The central portion of the receptacle

is filled up with a delicate network of jointed filaments surrounded by a gelatinous substance, this medullary structure forming a bond of union between the numerous conceptacles. The internal wall of the conceptacles is lined with a dense mass of delicate jointed filaments (fig. 253) standing vertically (*paraphyses*), among which appear the stalked *spore-sacs*, alone in the dicecious and moncecious forms, mixed with

Fig. 253.



Section of a conceptacle of F. canaliculatus, containing sporanges, antheridia, and paraphyses. Magnified 40 diameters.

antheridia in the hermaphrodite. The *antheridia* occur alone in similar conceptacles in the moncecious and dicecious forms. *F. canaliculatus* is hermaphrodite (like *Pycnophycus tuberculatus*, which, however, has antheridia only at the upper part of the conceptacle, near the pore, spore-sacs at the lower part); in *F. serratus, ceranoides, vesiculosus*, and *nodosus* the male and female conceptacles occur usually on distinct plants; but both kinds sometimes occur on *F. nodosus*. The male and female individuals of the dicecious species may often be distinguished, when mature, by the yellowish colour the antheridia give to the receptacles; and if these are exposed for a short time to the air, the antheridia are expelled in masses through the pores of the conceptacles, and form little orange-coloured papillæ. The female plants under similar circumstances exhibit olive-coloured papillæ at the mouths of the pores, consisting of masses of spores.

The *sporanges* or *spore-sacs* consist of ovate sacs, stalked, on the walls of the conceptacle (fig. 253); they have a double membrane—an outer, the *sporange* or *perispore*, and an inner, the *epispore*: these are undistinguishable until the spores escape; but then the epispore becomes evident as an inner sac. The epispore encloses at first a mass of olive-coloured cell-contents; in *F. canaliculatus* (*Pelvetia*) this divides into two spores, in *F. nodosus* (*Ozothallia*) into four, and in *F. serratus, vesiculosus*, and the other *Fuci* proper, into eight, by segmentation. When mature, the *sporange* bursts at the apex; the *epispore* enclosing the spores is expelled, and makes its way towards the pore of the conceptacle, and falls into the water, where it undergoes the following modifications. Taking *F. vesiculosus* as an example, the expelled epispore encloses eight spores, forming what Thuret calls an *octospore*. This swells; and the spores become rounded, separating from each other; and the upper part of the epispore begins to dissolve. The spores become removed from the lower part of the epispore (marked by the impression of the stalk of the sporange); and it then becomes evident that they are enclosed in a third membrane, which is attached to the *epispore* in the centre of its base, so that as the spores emerge from the dissolving summit of the epispore the internal membrane becomes stretched upward, until it finally bursts and sets the spores free. These changes of the octospore are generally passed through in about an hour, sometimes much more rapidly.

The *antheridia* consist of minute ovate sacs, attached in great numbers to hair-like filaments growing from the internal surface of the conceptacle (fig. 254). When young,

Fig. 254. Fig. 255.

Fig. 254. A branched cell of F. nodosus, bearing a perfect and an imperfect antheridium. Magn. 200 diams.

Fig. 255. Sac of an antheridium of F. serratus, nearly empty. Magn. 400 diams.

they are filled with colourless granular matter; but subsequently this becomes condensed into little corpuscles (*spermatozoids* or *antherozoids*), forming a greyish mass dotted with orange points. The sac is double; and the internal one is expelled from the outer like the epispore from the sporange, and finds its way out from the pore of the conceptacle. The spermatozoids which fill up the central part begin to move actively; and the sac soon bursts at one or both ends to discharge them. The spermatozoids (fig. 255) are excessively minute, transparent bodies, scarcely 1-5000″ long, enclosing a granule of an orange-colour in

most spores, but greyish in *F. canaliculatus*. The spermatozoids have two cilia, of unequal length, one directed forwards, the other backwards; the form of the spermatozoids and the direction of the cilia vary in different species,—the one directed forward usually moving with great rapidity, and producing locomotion, while the other trails behind like a rudder.

The most interesting and important point connected with the genus *Fucus* is the process of fecundation.

When a drop of sea-water containing active spermatozoids, is added to a slide upon which the free spores above described have been previously placed, the whole operation of the fertilization may be traced under the microscope. The spermatozoids attach themselves in great numbers to the spores, and by the motion of the cilia communicate to them a rotatory movement, often very rapid. The field of the microscope becomes covered with these large brownish spheres bristling with spermatozoids, and rolling in all directions among the crowd of those still unattached. After about half an hour, the movement of the spores ceases; the spermatozoids move for some time longer. In a few minutes after the contact of the spermatozoids, such fertilized spores will be found coated with a membrane, the presence of which is readily made out by placing the spore in syrup, which causes the granular contents to contract and shrink away from the envelope, which, moreover, may be coloured blue by sulphuric acid and iodine. The spore next begins to enlarge and grow by cell-division, one end becoming elongated into a transparent filament like a radicle (fig. 256); several more of these are afterwards formed

Fig. 256.

Spores of F. serratus in various stages of germination. Magnified 100 diameters.

as the upper part grows; and they become organs of attachment by which the young frond is fixed to a stone or other support. The above description corresponds in all essentials to the process as it occurs in the other species. The spores of *F. vesiculosus* have been fertilized with spermatozoids of *F. serratus* by Thuret; but no other experiments of hybridation were successful.

One or two other points deserve notice. The orange spot of the spermatozoids is coloured blue by sulphuric acid (like CHLOROPHYLL). Sugar and sulphuric acid colour the spermatozoids red (PROTEINE). The membrane of the sporange (*perispore*) is coloured blue by sulphuric acid and iodine (CELLULOSE); but this is not the case with the epispore nor the internal membrane, even after treatment with caustic potash. In *F. canaliculatus*, however, there is a laminated coat immediately surrounding the spores, which when placed in sea-water separate, while the coat swells and forms a kind of gelatinous envelope, which appears as if covered with cilia; these pseudo-cilia seem to be analogous to the similar appearances in the gelatinous sheath of DESMIDIACEÆ and other CONFERVOIDS.

The months from December to March are the most favourable for observing the above phenomena. No covering glass must be used on the slide, unless prevented by a thin glass support from pressing on the spores and deforming them. A power of 150 to 200 diameters suffices for most of the observations,—for the spermatozoids and the actual fecundation, a power of 300. Sea-water must always be used. The germination of the spores may be observed by placing them on glass slides moistened with sea-water, and keeping them under a bell-glass standing in a dish containing sand moistened with sea-water.

BIBL. Harvey, *Mar. Alg.* 18, pl. 1 D; *Phyc. Brit.* pls. 47, 52, 158, 214; Greville, *Alg. Brit.* pl. 181; Decaisne and Thuret, *Ann. Sc. Nat.* 3 sér. iii. 5; Thuret, *ibid.* xvi. 6, 4 sér. ii. 197, vii. 34; Sachs, *Bot.* 284; Bower, *Jn. Mic. Soc.* 1880.

FUNA'RIA, Schreb.—A genus of Funariaceæ (Acrocarpous Mosses), the common species of which (*F. hygrometrica*) is well known on account of the hygroscopic character of its fruit-stalk, which twists in drying, and untwists again when wetted. It exhibits stomata on the neck of the capsule (fig. 262).

BIBL. Wilson, *Bryol. Br.* 268; Berkeley, *Handb.* 176.

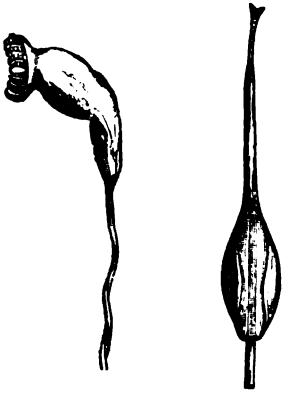
FUNARIACEÆ.—A family of Funarioideæ (Acrocarpous Mosses) of loosely-

tufted or gregarious habit, growing on the ground; the stem loosely leaved, very simple. Inflorescence monœcious; antheridial flowers disk-shaped, mostly terminal on a special branch. Antheridia small, oval. Archegones small, narrowly apiculate. Paraphyses filiform at base, club-shaped and articulate at the apex. Peristome, if present, cartilaginous, red, streaked, with solitary, oblique, trabeculate teeth.

British Genera.

Funaria. Capsule asymmetrically arched (fig. 257); orifice oblique, very small; stalk much curved, elongated, very hygroscopic and twisting. Calyptra ventricose-dimidiate, rounded at the base, obtuse, shorter than the capsule, or larger and truncate at the base (fig. 258). Peristome double, erect; outer of sixteen, oblique, broadly lanceolate-subulate, trabeculate teeth, with appendices near the point (fig. 259), chained together at the apex by a reticular disk; the inner as many as the outer, opposite and adnate at the base, lanceolate, granular, with a longi-

Fig. 257. Fig. 258.



F. hibernica.

Fig. 257. A ripe capsule with its twisted seta.
Fig. 258. An immature capsule, covered by its calyptra.
Magnified 25 diameters.

tudinal line. Cells of the operculum *circinately reticulate* at the apex.

Pyramidium. Calyptra squarely pyramidal, apiculate, entire at the base, far exceeding the capsule, totally covering it, inflated and persistent, bursting at the middle of the side, longer. Capsule symmetrical,

Fig. 259.

F. hibernica.
Teeth of the peristome, with appendices.
Magnified 150 diameters.

erect, pyriform, without a peristome. Operculum *regularly areolate.*

Physcomitrium. Calyptra mitre-shaped, split at the base into several laciniæ, entire below, much shorter than the capsule, with a long apiculus. Capsule symmetrical, straight, pyriform, without a peristome. Operculum regularly areolate.

Entosthodon. Calyptra bladder-like, dimidiate, with a long apiculus, entire, rounded or truncate, readily splitting. Capsule symmetrical, pear-shaped, straight, or declined on an arched stalk, with or without a peristome. Peristome, if present, horizontal, erect when dry, simple; internal wanting or scarcely perceptible; composed of very short laciniæ. Teeth lanceolate, *without appendages*, simple or twin, flat outside, trabeculate within, mostly oblique at the summit, connivent but not connate. Operculum regularly areolate.

Fig. 260.

Physcomitrium pyriforme.
Capsule, magn. 25 diams.

Amblyodon. Calyptra hood-like, narrow, very fugacious, longish, very slender, composed at the apex of very small, thickened, square cells. Capsule asymmetrical, pear-shaped, straight, with a peristome and an annulus. Peristome double: *external*—teeth sixteen, short, lanceolate, obtuse, erect, trabeculate with a slender longitudinal line; *internal*—teeth equal in number, lanceolate, subulate, fissile longitudinally in the middle,

smooth, much exceeding the external in length, yellowish, placed on a shortly-grooved membrane. Operculum regularly areolate.

FUNARIOIDEÆ. — A suborder of operculated Acrocarpous (terminal-fruited) Mosses, with broadly-oval spathulate leaves, furnished with a lax cylindrical nerve, composed entirely of large parenchymatous cells, lax and parallelogrammic at the base, lax, hexagonal, or polygonal towards the apex, often very densely filled with chlorophyll-granules, more or less pellucid. Capsule pyriform, apophysate, the neck (*collum*) mostly bearing stomata on its epidermis (fig. 262).

Fig. 261. Fig. 262.

F. hygrometrica.

Fig. 261. Portion of the annulus. Magn. 100 diams.
Fig. 262. Epidermis of the collum, with stomata. Magn. 100 diams.

This suborder is divided into two families:

FUNARIACEÆ. Stem very simple; terrestrial.

SPLACHNACEÆ. Stem very much branched; mostly occurring upon the dung of animals.

FUNGI.—A class of Cellular Flowerless Plants, growing in or upon damp (vegetable) mould, in or upon the wood and the herbaceous parts of living or dead plants, upon living or decaying animal substances, in solutions of organic matters, &c. A few occur on bare stones or other inorganic substances, as a species of *Cyphella* and some Myxomycetes; but this is quite exceptional. A very large portion of the plants belonging to this strange class are microscopic bodies, only to be made out clearly by means of a very high magnifying power. As in the rest of the Thallophytes, moreover, the reproductive bodies are simple and exceedingly minute in the larger forms of Fungi; consequently dissection under the microscope is requisite when it is desired to obtain a satisfactory insight into their natural history.

The Fungi do not appear to be capable of assimilating inorganic food, and are distinguished from healthy specimens of almost all other plants by the total absence of the colour depending on the presence of chlorophyll or its red modifications, and of starch; for it is scarcely to be doubted that the various colourless filamentous structures (Leptomitese, &c.) occurring in infusions, chemical solutions and the like, are Fungi, and not Algæ as some have supposed. They are allied by certain forms with the Algæ and with the Lichens; but they are distinguished from all outwardly similar forms of the first by the spore-bearing fruits always being elevated into the air, when mature, although the thallus or mycelium may be aquatic. The higher forms of Fungi can scarcely be confounded with the higher Algæ. The separation from the Lichens is more difficult; indeed some authors have come to the conclusion that the Lichens must be reduced to forms of Fungi. Yet the presence of green gonidial cells in the thallus will generally sufficiently distinguish the Lichens. We shall here follow the old plan; and the distinction ordinarily laid down is, that the Lichens are entirely aërial *incrusting* plants, while the Fungi have their vegetative structure *immersed* in the medium in which they grow. Some of the epiphyllous lichens, however, originate beneath the cuticle.

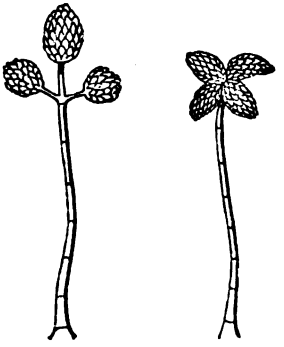
The structures of all Fungi exhibit a well-defined separation into two parts, namely:—1, a *mycelium* (thallus), or vegetative structure, consisting of a mass of exceedingly delicate, jointed and branched, colourless, interlacing filaments, forming a kind of cottony or felty mass when growing in the earth, in vegetable structures, &c., or cloudy flocks when growing in decomposing liquids. In some cases, as in certain *Sphæriæ*, the threads are woven into a close mass, or, as in *Phallus*, into filiform cords; while in the Myxomycetes the threads become obsolete or are replaced by a jelly-like substance resembling sarcode. 2, of the reproductive structure or *fruit*, which, unlike the mycelium, differs extremely in appearance in the various tribes.

The *mycelium* may be well examined in the "spawn" used for planting mushroom-beds; this cottony substance consists of the mycelium of that plant. The formation and growth of the mycelium of the microscopic species, such as moulds, mildews, &c., may be traced under the microscope by scattering some of the dust-like fructifications (as the blue powder of common paste-mould) upon

slips of glass, and keeping them in a warmish place under a bell-glass over water, for several days. The filaments will be seen spreading from the spores in all directions, and often advancing to the formation of the fructification.

The *fructification* of the simplest Fungi is nothing more than a modification of one or more cells at the end of a filament which rises up from the general body of the mycelium. In TORULA, one or more globular cells are produced at the ends of filaments composed of elongated, more or less cylindrical cells (Pl. 26. fig. 7); these globules drop off, and develop into new mycelia. In *Botrytis* (figs. 77, 78, 263), the tips of the

Fig. 263.

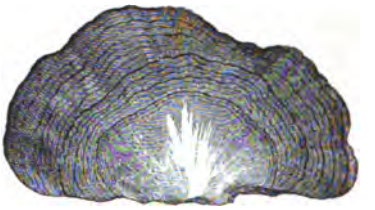


Botrytis (Polyactis) vulgaris.
Fertile filaments. Magnified 200 diams.

fertile filaments are branched and clothed with heaps of spores arising from short pedicels. In *Penicillium* (Pl. 26. fig. 15), the filament which rises up, forks at the end, each branch forking again, and so on, until a close tufted pencil of branches is formed, each branch bearing a bead-like row of spores, which drop off separately. Innumerable modifications of this mode of fructification are met with in the microscopic Fungi; and the same plan also forms the basis of the fructification of some of the highest forms.

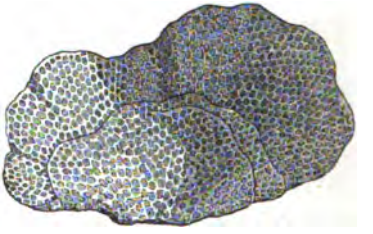
The way in which the greater complexity arises is by an increased development of the structures supporting the layer of tissue (*hymenium*) upon which the spores are borne. Thus, in the leathery Fungi growing over damp trunks of trees and dead wood, such as the *Hydna*, *Thelephoræ*, *Hexagonia* (figs. 264, 265), the conspicuous

Fig. 264.



Hexagonia glabra.
Upper surface. Nat. size.

Fig. 265.



Hexagonia glabra. Nat. size.
Lower surface, with orifices of the hymenium.

fungous mass (which is all that ordinary observers notice) developed from a flocculent mycelium imbedded in the matrix on which the plant grows, is a *fruit*, composed of dense cellular tissue, and possessing pits, channels, cavities, or the like, the walls of which are clothed with papillose cells, each bearing four free sporanges, which drop off singly to reproduce the plant. The Mushroom, as gathered and brought to table, is merely the 'fruit' of the Fungus (*Agaricus*); and similar cells bearing four sporules are found clothing the flat sides of the paper-like plates or 'gills' which radiate on the under side of the flat 'cap' of the Fungus. (See BASIDIOSPORES.)

A second kind of fructification is seen in the PHYCOMYCETES, where the upright filament arising from the flocculent mycelium does not bear free spores as in *Penicillium*, *Botrytis*, &c., but a comparatively large sac, filled with minute sporules; and these sporidia are scattered by the bursting of the sac. In the *Helvellæ*, *Peziza*, *Spathulea* (fig. 40), *Leotia* (fig. 41), &c., structures of a fleshy or leathery character, growing upon damp wood &c., we have counterparts to the *Hydna*, *Thelephoræ*, &c., since they have fruits arising from a flocculent

mycelium; but their spore-bearing cells appear as definite groups of vesicles or sacs of elongated form, producing sporules (usually eight but sometimes two, multiples of two, or multiples of eight) in their cavities. In the Truffles (*Tuber*, *Elaphomyces*, fig. 185), &c. the sporidia are found in twos, fours, or eights, in sacs in the internal convoluted substance; while in the Puff-balls, except *Scleroderma*, where the internal mass finally breaks up into powder, the spores are developed free, as in the Agarics &c. More minute accounts of these structures will be found under THECASPORES and the various genera.

It was long imagined that these two modes of producing the spores afforded a firm basis for the classification of the Fungi; but recent discoveries seem to indicate that characters derived from the fructification are as unsafe here as in the Algæ. Thus, if De Bary's observations on *Agaricus* are correct, an asciferous structure occurs in the highest group of the basidiosporous classes. It is now, however, pretty certain that the ascigerous structure which he found on *Agaricus melleus* was a species of Hyphomyces. The orders Coniomycetes and Ascomycetes also are confounded together by the numerous genera which exhibit both *asci* and *stylospores*, although the latter may perhaps be regarded as merely a modification of the ascosporous structure. Tulasne has also pointed out a peculiar structure analogous to the so-called *spermatozoids* of the Lichens, namely very minute cylindrical bodies growing upon free points from the fructifying surfaces of the Fungi; these bodies, quite distinct from the basidiospores and thecaspores, are called *spermatia* (Pl. 26. figs. 3, 4, 17 *s*). According to Cornu, these germinate.

Certain more recent observations on the sexual reproduction of the Fungi require special notice.

In the Saprolegniæ, this has been described under ACHLYA. In *Cystopus*, the conidia are stated to be formed at the ends of the branches. Subsequently sporangia or oogonia are produced by the swelling of the ends of branches of the mycelium; while on another branch, a shoot grows towards the sporangium, swells, and forms an antheridium. A fine tube from this bores through the sporangium, and produces fertilization.

In the Ascomycetes, a mycelium is formed from the true spores; on this are produced conidia, which again produce mycelium. On this are ultimately produced sexual organs, consisting of the pollinodium or antheridium, and the carpogonium or sporange: these are often much alike, but the latter is usually larger, and composed of more numerous cells. The pollinodium forms a slender branched cell, not containing spermatozoids. It comes in contact at the apex or through its whole length with the sporange, which it fertilizes by diffusion, as in the pollen-tube of the embryo-sac; but there is no fusion of contents.

In *Ascobolus*, the carpogonium or sporange consists of a curved row of cells. The slender branches of the pollinodium become closely applied to and fertilize it. After this, one of the middle cells of the carpogonium grows more than the others, and produces buds which ultimately form the asci.

In *Peziza*, the end-joints of the carpogonial branches form ovate vesicles with an apical appendage. The slender wedge-shaped pollinodium arises on the same branches beneath the carpogonium, with which it becomes connected. Numerous filaments then spring from the base of the sexual organs, forming a dense network—the hymenial layer, in which the asci are subsequently produced. It appears that *Botrytis cinerea* is a conidiiferous form of *Peziza* (*Fuckeliana*). A remarkable peculiarity in the sexual formation of spores in many Fungi, as in some Algæ is, they are frequently not formed in the directly fertilized cell, but in the newly formed cells springing from its sides or base.

The sexuality of the Ascomycetes, however, is disputed.

Zoospores have now been discovered in PERONOSPORA and CYSTOPUS.

The minutiæ of the structure of the Fungi may be treated most satisfactorily under the heads of the orders (ASCOMYCETES, CONIOMYCETES &c.), since the elements are very similar in all, while the modes of combination are very varied, and in most cases peculiar to the families.

In consequence of the numerous discoveries of Tulasne, De Bary and others, the older arrangement of the Fungi, based upon the views of Fries, is not at present satisfactory. We adopt, therefore, that of Sachs, slightly modified; retaining, however, in great measure the nomenclature for those Fungi which are manifestly merely states of higher forms, and are not autonomous.

I. SCHIZOMYCETES. Consisting of threads which break up into minute cylindrical bodies, sometimes straight, sometimes curved, or microscopic globular particles; in the former case, sometimes at length swarming and forming a cloudy gelatinous mass: in solutions or in decomposing substances.

II. PHYCOMYCETES. Aquatic or epiphytous, propagated by zoospores, or by oospores arising from fertilization.

1. *Saprolegniæ*. Aquatic.
2. *Peronosporeæ*. Epiphytic.
3. *Mucorini*. Fermentigerous; Saprophytic (Moulds).

III. HYPODERMIÆ. Epiphyllous.

1. *Uredineæ*. } Smuts &c.
2. *Ustilagineæ*. }

IV. BASIDIOMYCETES. Spores seated upon Basidia or Sporophores arising from a distinct hymenium.

1. *Tremellinæ*. Tissues gelatinous; hymenium exposed.
2. *Hymenomycetes*. Tissue cellular, hymenium inferior (Mushrooms &c.).
3. *Gasteromycetes*. Hymenium intricate, cellular, internal (Puff-balls &c.).

V. ASCOMYCETES. Sporidia contained in Asci (thecæ).

1. *Protomyces*. More properly perhaps associated with Peronosporeæ.
2. *Tuberaceæ*. Hymenium as in Gasteromycetes (Truffles &c.).
3. *Onygeneæ*. On animal substances, very rarely on decayed wood.
4. *Pyrenomycetes*. Asci contained in perithecia.
5. *Discomycetes*. Hymenium superior, disciform.

VI. MYXOMYCETES. Spores amœboid in germination, subsequently conjugating.

BIBL. Berkeley, *Fungales*, Lindley's *Veg. Kingd.*: *Fungi*, in Hooker's *Br. Fl.* and *Crypt. Bot.*; also numerous papers in *Ann. N. H.*; Montagne, *Ann. N. H.* ix.; Corda, *Ic. Fung.* 1837-40; Greville, *Scott. Crypt. Fl.*; Nees v. Esenbeck, *Syst. Pilze*; Fries, *Syst. Myc.* & *Summa Veget.*; Tulasne, *Fung. Carp.* 1860-5; De Bary, *Frucht. Ascomycet.* 1863, 11; id. & Woronin, *Morph. &c. d. Pilze*, 1870; Tulasne, *Ann. Sc. N.* 1866, vi. 217; Janczewsky, *Bot. Zeit.* 1871; Fuisting, *Bot. Zeit.* 1868; Baranetzki, *Bot. Zeit.* 1872; Sachs, *Bot.* 1874, 307; Cornu, *Ann. Sc. N.* 1876 (*M. M. Jn.* xvii. 1877, 295); Tieghem, *Ann. Sc. N.* 1875, ii. 365 (*sexuality disputed*); Cooke, *Br. Fungi*, 1871 (*descript. of sp., & figs. of gen.*); Brefeld, *Schimmelpilze*, 1881; Bary & Woronin, *Morph. d. Pilze*, 1881.

FUNGUS-BED.—Mycologists find this very useful for growing the microscopic Fungi. It is best made of a small wooden box half-filled with damp bog-earth, and covered with a plate of glass. In winter it should be kept in a warm room.

FURCELLA'RIA, Lamx.—A genus of Cryptoneniaceæ (Florideous Algæ), containing one common British species, growing on rocks and stones between tide-marks, consisting of a fastigiate, dichotomously-divided frond, 6 to 12″ high, of a brownish-purple colour, and somewhat cartilaginous texture. The tetraspores, which are linearly arranged, are imbedded in the periphery of the swollen pod-like extremities of the branches. Conceptacular fruit as yet unknown.

BIBL. Harvey, *Mar. Alg.* 147, pl. 18 C; *Phyc. Brit.* pl. 94; Greville, *Alg. Brit.* pl. 11; *Eng. Bot.* pl. 894; Thuret, *Ann. Sc. N.* 1855, iii. 5.

FURCULARIA, Lam.—A genus of Rotatoria, of the family Hydatinæa.

Char. Eye single, frontal; tail-like foot forked. Several species; all freshwater but one, which is marine.

F. Reinhardtii, E. (Pl. 43. fig. 34; fig. 35, teeth). Body fusiform, truncated in front; foot elongate, cylindrical; toes two, short; length 1-120″.

Found creeping upon *Laomedea geniculata*.

F. gibba. Body oblong, slightly compressed, dorsally convex, ventrally flat; toes styliform, half as long as the body; length 1-96″. Freshwater.

BIBL. Ehrenb. *Infus.* 419; Dujardin, *Inf.* 648; Gosse, *Ann. N. H.* 1851, viii. 199.

FUSA'RIUM, Lk.—A genus of Stilbacei (Hyphomycetous Fungi), not very satisfactorily distinguished from FUSISPORIUM; but having a firm, cellular, pulvinate, fleshy stroma, upon which the spores are borne on distinct sporophores glued together into an erumpent discoid stratum. *F. tremelloides* is common, forming roundish orange-red spots on decaying nettle-stems; but it is now believed to be a spore-bearing state of *Peziza fusarioides*. *F. roseum* forms little gregarious red dots on the stems of beans, Jerusalem artichokes, and other plants.

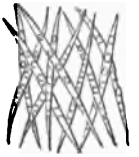
BIBL. Berk. *Hook. Br. Fl.* ii. pt. 2. 355; Fries, *Syst. Myc.* iii. 469, *Summa Veg.* 472; Greville, *Sc. Crypt. Fl.* pl. 20; Fresenius, *Beitr. z. Mycol.* Heft 1. 35.

FUSID'IUM, Lk.—A genus of Mucedines (Hyphomycetous Fungi), characterized by very delicate white or coloured flocci, which do not form a moist or gelatinous mass as in *Fusisporium*, and are very evanescent. Spores straight, filiform. The species grow on dead leaves, forming a thin powdery stratum.

BIBL. Berk. *Outl.* 357; Cooke, *Br. Fung.* 609; Greville, *Crypt. Fl.* pl. 102.

FUSISPO'RIUM, Lk.—A genus of Sepedoniei (Hyphomycetous Fungi), growing upon vegetable substances often when decaying, characterized by elongate fusiform curved septate spores (fig. 266), which ultimately form a gelatinous mass, the flocci being in general more or less obscure, or if present very delicate, the spores in fact forming the principal element. Numerous species are recorded as British. *F. atrovirens* is destructive to onions. *F. betæ* common on decaying mangold-wurzel. *F. fœni* sometimes runs over the cut surface of a haystack, forming broad orange-red patches.

Fig. 266.



Fusisporium. Spores. Magn. 400 diams.

BIBL. Berk. *Hook. Br. Fl.* ii. pt. 2. 251, *Ann. N. H.* vi. 438, pl. 14. fig. 28; 2 ser. vii. 178; Fries, *Syst. Myc.* iii. 442, *Sum. Veget.* 473; Greville, *Sc. Crypt. Fl.* pl. 102. figs. 1 & 2.

FUSULI'NA, Fisch.—A genus of spiral, hyaline Foraminifera, near *Nonionina* and *Nummulina*, but fusiform instead of nautiloid, the umbilical axis of the shell being much extended. The lateral tapering elongations of the chambers in some cases are simple, yielding symmetrical casts figured by Ehrenberg as *Borelis* in the 'Mikrogeologie;' but in others the chambers are divided throughout by labyrinthic segmentation, giving more complex casts and sections.

F. cylindrica (Pl. 24. f. 15) and its varieties form enormous masses of limestone in the Carboniferous system, in Russia and North America.

BIBL. Carpenter, *Foram.* 304; *M. Mic. Jn.* 1870, 180; Parker and Jones, *Ann. N. H.* 1872, 260; Brady, *ibid.* 1876, 414; Möller, *Foram. Russ.* 1878.

G.

GALLIONEL'LA, Bory, = MELOSIRA, Agardh.

GALLS.—These are abnormal growths, tumours as they might be called, produced upon or in vegetables by the action of animals, especially insects of the order Hymenoptera. They were supposed to arise from the irritation caused by a poisonous liquid discharged into the orifice made by the insect for the introduction of its egg. At all events a convergence of the nutritive juices towards the wound takes place, whence results a kind of hypertrophy of the tissues, and frequently the accumulation of such substances as starch in the cells. The forms may be regular or irregular; most of them are characteristic, as, for example, the well-known nut-gall, the oak-apple, the bedeguar of the rose, &c. Both cellular and vascular structures contribute to form the substance of galls. We cannot enter into their minute structure here, but refer to an elaborate paper by Dr. Lacaze-Duthiers and to Adler's more recent memoir. Adler's plates will enable the identification of most, if not all, the British oak-galls, and will perhaps lead to the discovery of others. See APHIDÆ, CYNIPIDÆ, and PHYTOPTIDÆ.

BIBL. Lacaze-Duthiers, *Ann. Sc. Nat.* 3 sér. xix. 273, where also the earlier literature is given; Adler, *Zeitschr. wiss. Zool.* liii. 151; M'Lachlan, *Ent. Mn. Mag.* 1881, xvii. 259.

GALUM'NA, Heyden, Gervais.—A genus of Arachnida, of the order Acarina, and family Oribatea.

Char. Abdomen subglobular, depressed; sides of the pseudo-thorax forming a salient or wing-like angle; legs of moderate length.

This genus approximates to *Belba*.

The three species, the bodies of which are of a blackish, blackish-chestnut, or ash colour, are found on mosses.

BIBL. Walckenaer, *Arachn.* (Gervais); Hermann, *Mém. Aptér.* 91; Koch, *Deutsch. Crustac.* &c.

GAMA'SEA.—A family of Arachnida, of the order Acarina.

Characterized by the free filiform palpi, the chelate mandibles, and the 7-jointed legs with two claws and a caruncle. Generally parasitic, and found on insects and birds; some upon fishes, reptiles, and mammals; eyeless.

Dermanyssus. Body soft; last joint of palpi smallest; labium acute; mandibles—of male, chelate, outer claw very long,—of female, ensiform; legs with two claws and a caruncle, anterior longest, coxæ approximate. On birds and bats (Pl. 6. fig. 24).

Gamasus. Body hard; labium trifid;

body with usually two dorsal plates; anterior legs generally longest, second pair sometimes incrassate; no eyes. On insects, &c. (Pl. 6. fig. 26).

Pteroptus. Body depressed; last joint of palpi longest; legs stout, with short joints. On bats (Pl. 6. fig. 39).

Uropoda. Body depressed, with a round dorsal plate, and a deciduous funnel-shaped anal peduncle, serving to fix the body. On beetles, mosses, &c. (Pl. 6. fig. 25).

Halarachne. Body elongate, with a dorsal and ventral plate; labium bifid. In the nostrils of a seal (*Halichœrus*).

See also ARGAS and CARIS.

BIBL. Gervais, *Walckenaer's Apt.* iii. 215; Dugès, *Ann. Sc. Nat.* 2 sér. 24; Koch, *Deutsch. Crustac.* and *Uebersicht*; Murray, *Ec. Entom.* 157; Mégnin, *Paras.* 113; Kramer, *Wiegm. Arch.* 1876, i. 28; *Tr. Mic. Soc.* 1880, 177.

GAM'ASUS, Latr.—A genus of Arachnida, of the order Acarina, and family GAMASEA.

Species numerous; mostly parasitic upon insects; some found upon the ground; others on the higher animals.

G. coleoptratorum (Pl. 6. fig. 26). Found upon dung-beetles (*Geotrupes* &c.). Anterior coxæ attached at a little distance from those of the second pair; tarsi (fig. 26 *a*) with two claws and an elegant caruncle; palpi of moderate length; mandibles terminated by a curved hook; fawn-coloured.

G. marginatus. Body broader behind; darker. Found in the human brain; also on a fly, and on beetles.

G. muscarum. On the house-fly.

G. auris. In aural meatus of ox.

Other species.

BIBL. That of the family; Leidy, *Proc. Acad. Phil.* 1872 (*Ann. N. H.* 1873, xi. 79); Murray, *Ec. Ent.* 158.

GAM'MARUS, Latr.—A genus of Crustacea, of the order Amphipoda, and family Gammarina.

The searcher for the freshwater Diatomaceæ will surely meet with *Gammarus pulex* (Pl. 18. fig. 22), the freshwater shrimp, in muddy brooks and streams. It attains a length of about 1-2″, and moves its curved body through the water by means of its caudal appendages, frequently lying on its back or side during the process. Gervais distinguishes *G. fluviatilis* from *G. pulex*, by the former having a dorsal spine at each abdominal joint, whilst in the latter this is absent.

There are twenty-three species of *Gammarus*, many of them marine. *Talitrus saltator*, the sand-hopper, found burrowing in and hopping upon the sand of the sea-shore, also belongs to the family *Gammarina*.

BIBL. Desmarest, *Consid. gén. Crust.*; M.-Edwards, *Crustac.* iii.; Gervais, *Ann. Sc. Nat.* 1835, iv.; Westwood, *Phil. Tr.* 1835; Bate and Westwood, *Ann. N. H.* 1857, xix. 135; Rentsh, *Gamm. orn.* 1861.

GANGLION-GLOBULES, or NERVE-CELLS. See NERVES.

GAPES.—A disease occurring in poultry, arising from entozoa (*Sclerostoma* and *Syngamus*) in the air-passages.

GARVEI'A, T. S. Wright.—A genus of Hydroid Polypes, fam. Atractylidæ.

G. natans. Body red, tentacles yellow; marine; height 1″ On rocks and sea-weeds.

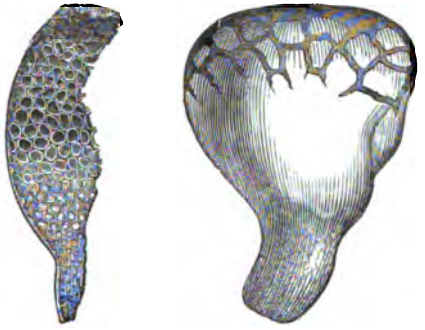
BIBL. Hincks, *Brit. Zooph.* 101.

GASTEROMYCE'TES. — A tribe of Basidiomycetous Fungi, characterized by the production of their free spores upon basidia seated on a sporiferous structure forming convolutions in the interior of an excavated fruit, which ultimately bursts to allow the sporiferous structure to expand and scatter its spores. The fruit of the Gasteromycetes is ordinarily a globular, elliptical, or shapeless mass, varying in size from microscopic minuteness to the dimensions of large balls, often stalked, arising from an inconspicuous flocculent mycelium. This external body consists of a leathery or membranous, simple or double sac (*peridium*), which bursts in various ways at maturity. When examined young, these Fungi appear solid; but as they advance, various structures become gradually marked out in their interior, and appear more and more distinct until mature.

In the Nidulariacei little *conceptacles* are developed in the interior of the sac-like peridium; and when the latter is mature, it opens like a cup or vase at its summit, exhibiting the conceptacles within, lying like eggs in a nest. These conceptacles are hollow, and lined with basidia bearing free spores.

The Trichogastres exhibit in most cases the appearance of a leather ball, arising from an inconspicuous flocculent mycelium; but in *Broomeia* the peridia are imbedded in large numbers in a common fleshy matrix. The internal structure differs to a considerable extent in its earlier stages. The *peridium* is either single or double, the outer being often quite free, and becoming everted

Fig. 268. Fig. 267.



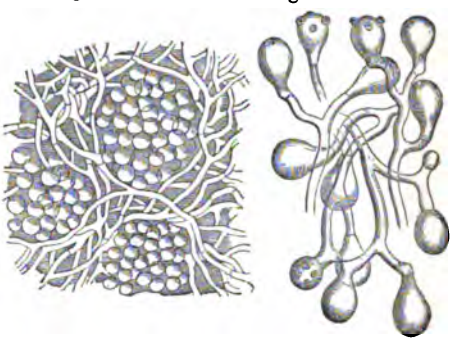
Polysaccum crassipes.
Fig. 267. Natural size.
Fig. 268. Section from ditto, showing the loculi.

Fig. 269.

Polysaccum crassipes.
Cells of the hymenium, with basidia and spores.
Magn. 400 diams.

at the time of dehiscence. The interior of *Polysaccum* (fig. 268) and *Scleroderma* (fig. 270) consists, in the early state, of a mass of cellular matter, formed by the prolongation of the peridium, in the form of septa, in all directions into the interior, so as to divide it into chambers, each of which is lined with a hymenium or conceptacle, hollow in the centre, into which project the ends of the filaments, bearing basidia with two to six spores. At the epoch of maturity all the internal structure has vanished, except the spores and detached particles of the filaments on which they were developed; and these escape, on the bursting of the now bag-like peridium, as a fine powder. In *Lycoperdon*, &c., it is not the peridium

Fig. 270. Fig. 271.

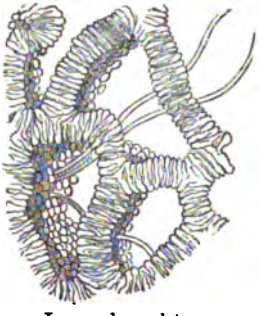


Scleroderma vulgare.
Fig. 270. Portion of the internal mass. Magn. 200 diams.
Fig. 271. Cells of the hymenium, with basidia and spores. Magn. 400 diams.

which is continued inwards to form chambers; it forms a single or double sac, containing a fleshy substance (*gleba*), hollowed out into sinuous cavities clothed with basidia. In course of ripening, the spongy mass disappears, leaving only a collection of minute spores and filamentous fragments, which are emitted by the bursting of the peridium,—a process exhibiting many curious peculiarities in this group.

The Phalloidei are roundish or ovoid fleshy balls in their earlier stages, but when opened exhibit a distinct *peridium* and a central lacunose sporiferous structure. The

Fig 272.



Lycoperdon cælatum.
Section of the *gleba* showing the loculi, on the walls of which the spores are produced.
Magn. 200 diams.

peridium consists of two layers, an inner and an outer, united by firm gelatinous

tissue traversed by transverse membranous septa, and exhibits a tendency to split, like an orange, into quarters. When the peridium bursts, which it usually does at the apex, the central sporiferous structure emerges, under various forms. In *Phallus* it is a capitate or clavate column; in *Clathrus* (fig. 273), an elegant, globular, fleshy trellis; in *Aseroe*, a column with a stellate head, &c. In all cases, the spores, which are developed on convolutions of the fleshy sporiferous mass (*gleba*), on basidia, are found detached and confluent into a wet viscid mass adhering to the sporiferous surface at the time this has emerged from the peridium and expanded to its full size. This wet condition of the mature sporiferous layer is distinctive between the Phalloidei and the Hymenomycetes, to which they bear many relations.

Fig. 273.

Clathrus cancellatus. The sporiferous frame-work emerged from the ruptured peridium. 1-10th nat. size.

The Hypogæi receive their name from their subterraneous habit of growth; in which they resemble Truffles, a tribe of Ascomycetes bearing much external similarity to these plants (see TUBERACEI). The general character is that of globular or depressed balls, growing underground, sessile on a flocculent mycelium. They exhibit a peridium enclosing a fleshy *gleba*, excavated into sinuous cavities lined by a membrane bearing basidiospores. These fruits do not burst, but set free their spores by decaying.

Lastly, the Podaxinei bear much resemblance to the Trichogastres; but they always contain a central fleshy column, called the *hymenophore*. The young plants exhibit a peridium passing internally into a fleshy mass hollowed into labyrinthiform cavities (fig. 275), with a solid column in the centre of all. The cavities are lined by a membrane bearing basidiospores (fig. 277). The *gleba* sometimes breaks up into a pulverulent mass of spores and filaments; sometimes it is permanent. The internal structure of this order presents many points of great morphological interest, but rather as regards the mode of arrangement and composition of the tissues than the character of the ultimate elements themselves, which consist of the ordinary filamentous interwoven tissue of Fungi in the general mass of the structure, and of globular loosely packed cells in the sporiferous regions.

Fig. 274. Fig. 275.

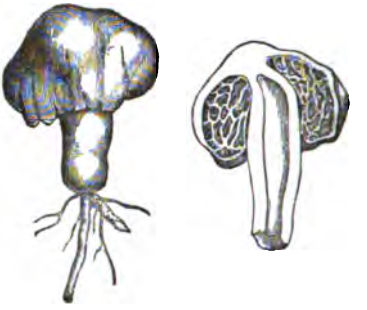
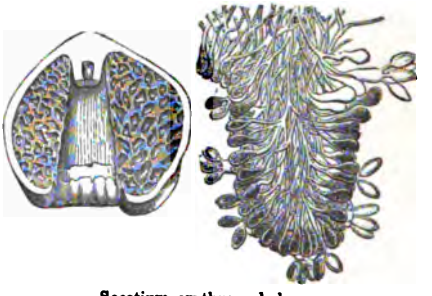


Fig. 276. Fig. 277.



Secotium erythrocephalum.

Fig. 274. Natural size.
Fig. 275. Vertical section.
Fig. 276. Vertical section through the head, showing the labyrinthiform cavities.
Fig. 277. Portion of a septum dividing the loculi, bearing basidia. Magnified 400 diameters.

Synopsis of the Families.

PODAXINEI. *Peridium* dehiscent, enclosing a sinuously excavated, fleshy, sporiferous mass, falling to powder or permanent when mature, with a central solid column.

HYPOGÆI. *Peridium* indehiscent, coating a fleshy, sporiferous mass. Subterraneous.

PHALLOIDEI. *Peridium* dehiscent, enclosing a fleshy, sporiferous mass, which emerges from the burst peridium as a club-shaped or capitate column, or a globular network of wrinkled fleshy processes, coated on the sporiferous surfaces with a dark-coloured foul-smelling slime (composed of minute spores imbedded in mucus).

TRICHOGASTRES. *Peridium* double, more or less distinct, dehiscent, enclosing a multilocular, fleshy, sporiferous mass, which finally breaks up into dust, without a central column.

NIDULARIACEI. *Peridium* dehiscent, and then forming a cup or nest, containing one or many globose, oval or discoid conceptacles, lined with filaments bearing spores.

BIBL. See the Families.

GASTROCHÆ'TA, Duj.—A genus of Infusoria, of the family Enchelia (Duj.).

Char. Body oval, with one side convex, the other being traversed by a longitudinal furrow, which is furnished with vibratile cilia, principally at the ends.

G. fissa (Pl. 31. fig. 7). Body semitransparent, colourless, oval, truncated in front, with a very minute blunt point at the middle of the posterior margin, convex and smooth above. Freshwater; length 1-400".

BIBL. Dujardin, *Infus.* p. 385.

GAUDRYI'NA, D'Orb.—A Textularian Foraminifer, having the early chambers arranged triserially, as in a *Verneuilina*, making the shell three-keeled at first; but it subsequently becomes compressed and wrinkled, the chambers being alternate with biserial growth, as in *Textularia*. The aperture is usually, as in *Textularia*, a slit on the inner wall of the chamber; but it may be almost terminal and somewhat rounded and pouting, thus passing into *Heterostomella*. Some *Gaudryinæ* are twisted and Buliminoid. Fossil and recent. Pl. 23. fig. 48, *G. pupoides*, D'Orb., in the Chalk.

BIBL. D'Orb. *For. Foss. Vien.*; Parker & Jones, *Annals N. H.* ser. 3, xi. 127.

GELATINE.—This chemical proximate principle constitutes the basis of the various forms of connective tissue, as existing in the true skin, areolar tissue, tendon, ligaments, the swimming-bladder of fishes (isinglass); also of bone &c.

It possesses no microscopic characters; it forms a most valuable vehicle for the colouring-matters of liquids for injection.

GELIDI'UM, Lamx.—A genus of Cryptonemiaceæ (Florideous Algæ), of which one species (*G. corneum*) is very common on our shores. It has a red, pinnated, horny frond, from two to six or eight inches high; very variable in the appearance of its pinnate subdivisions; both spores and tetraspores are found on the ramules, the former in favellidia immersed in swollen ramules.

BIBL. Harvey, *Mar. Alg.* 137, pl. 17 B, *Phyc. Brit.* pl. 53.

GEMELLA'RIA, Sav.—A genus of Cheilostomatous Polyzoa, of the order Infundibulata, and family Gemellariidæ (Eucratiidæ, H.)

G. loriculata (Pl. 36. fig. 26). Cells inversely conical, obliquely truncate. Common a few fathoms below low water-mark.

BIBL. That of the family.

GEMELLA'RIIDÆ.—A family of Cheilostomatous Polyzoa, of the order Infundibulata.

Distinguished by the unjointed zoary, and the cells being opposite in pairs. Two genera:

Gemellaria. Cells jointed back to back, all the pairs facing the same way; orifice oval, oblique; no birds'-heads (Pl. 36. fig. 26).

Notamia. Each pair of cells arising from the next pair but one below it by tubular prolongations; pipe-shaped birds'-heads above each pair (Pl. 36. fig. 21).

BIBL. Johnston, *Br. Zooph.* 293; Busk, *Mar. Polyzoa*, 34; Gosse, *Mar. Zool.* ii. 14; Hincks, *Polyz.* 17.

GEMMÆ.—This term is applied to those cellular structures, formed in Flowerless Plants, which become detached, and reproduce the individual independently of the spores.

GEMMULI'NA, D'Orb. See BIGENERINA.

GENERATIONS, ALTERNATION OF.—The ordinary plan upon which the reproduction of animals is effected, viz. that of sexes, involving the action of the spermatic secretion upon the ova, and the subsequent series of changes ultimately giving rise to new individuals resembling the parents, is in some instances departed from; and the embryos of certain animals, after their escape from the ova, do not become directly developed into individuals resembling the parents, but produce a new, larval kind of being, which produces generations of the same larval or other kinds, the last of which resemble the original parents.

While, therefore, in animals reproduced by the ordinary sexual process, the new individuals resemble each other, or differ only in sex, in those which produce these alternate or intermediate generations the new individuals differ from the parents and even from each other, until the last of the series returns to the state of the first parents. This mode of reproduction has received the above name, from the alternation of the larval generations with the ordinary sexual form.

Many instances of this process are mentioned under the heads of the Classes &c. in which they occur; as under ACALEPHÆ,

Aphidæ, Entozoa, Tænia, &c. Thus, for instance, in the Acalephæ, the ciliated embryo (Pl. 49. fig. 6) produced by the ordinary sexual process becomes fixed (fig. 7), and passes into the state of an asexual polype (fig. 8); it then reproduces new individuals from gemmæ and stolons (fig. 9), ultimately becoming segmented (fig. 10), and producing new individuals which resemble the sexual parents. The intermediate or nurse forms are those represented in figs. 7–10. Again, in *Tænia*, the *Cysticercus* or *Echinococcus* forms the nurse, producing new individuals by gemmation, these, on reaching the alimentary canal, becoming transformed into *Tæniæ* with sexual organs.

But the alternation of generations, or a modification of it, also occurs in animals in which sexes are not known to exist, as in some Infusoria and Rhizopods. In these, the ordinary plan of reproduction by division and gemmation is departed from, and an animal differing from the parent, or a nurse-form resembling or identical with *Acineta* and *Actinophrys*, is produced, which gives rise to embryos subsequently growing into the parent form. But in these instances the nurse-form is the result of a kind of metamorphosis, rather than of generation.

In the Aphidæ, the process is exhibited by the repeated formation of viviparous broods of beings, from apparently female insects, without impregnation, the final progeny being sexual. This is called *parthenogenesis*.

The phenomena designated by the phrase alternation of generations are also strikingly exemplified in the vegetable kingdom; but the conditions are very complicated, and the analogies with those occurring in animals somewhat difficult to trace. The Mosses, Hepaticæ, and Ferns afford very clear analogies to the Medusæ; and others admit of being made out; but it appears to us that Steenstrup and others have confounded various distinct points, in the parallel drawn between the alternation of generations of animals and the metamorphoses (commonly so-called) of plants. We will endeavour to give a summary of the general facts connected with the doctrine.

1. All animals and plants reproduced by a sexual process (and there is reason to believe that this will ultimately be found universal), originate from a simple protoplast or cell, and undergo a series of changes, in the course of their development to the complete form endowed with sexual organs, in which they assume forms analogous to animals (or plants) belonging to classes of lower (simpler) organization.

2. In the highest animals, the metamorphoses are *intra-uterine*, as in most of the Mammalia; in the lower animals these metamorphoses are in part or wholly *extra-uterine*. In the higher plants the changes are partly *intra-uterine* (*i. e.* the embryo has already become a leafy axis within the ovary, but it becomes perfected into the sexual form subsequently), in the lower partly or wholly *extra-uterine*.

3. The lower animals and all plants are capable of an asexual or vegetative reproduction, by the isolation and separation of a portion of their substance.

4. Many animals and all plants are capable of being multiplied by this vegetative reproduction in their intermediate stages of extra-uterine development; and in such cases the reproduction, fissiparous, gemmiparous, or other, assumes the character peculiar to the class to which the intermediate form is analogous (*e. g.* the polypiform reproduction of the Acalephæ, the confervoid growth and multiplication of the proembryo of the Mosses). The product of the vegetative reproduction is either like or unlike the body which produces it: in the former case the vegetative reproduction will be repeated; but in the latter case the product is usually provided with sexual organs, and the cycle of development is completed by the reproduction of a fertilized ovum. In the latter case we have what is called an *alternation of generations*.

It will be evident that we here exclude from consideration the metamorphoses within the sphere of the individual *shoot* on plants—that is, the metamorphosis of the leaf, the morphological element of the higher plant. It appears to us that these are not to be taken as parallels to the metamorphoses of animals comprehended by Steenstrup under the name of alternation of generations, which would rather be found in the cases where bulbs, bulbils, tubers, &c. appear in the place of shoots, as the product of branch-buds. The analogy would hold also with the *gemmæ* of the Mosses, &c., and with the *gonidia* of the Thallophytes. Our space does not admit of a more minute examination of the subject. Illustrations of the phenomena in vegetables will be found under Ferns, Mosses, Confervoideæ, Lichens, certain Fungi, *e. g.* Erysiphe, Penicillium, &c.

Strictly speaking, the term alternation of generations is incorrect; the process really consisting of an alternation of reproduction by gemmation, with that by sexual reproduction.

BIBL. Steenstrup, *Altern. of Gen.* (*Ray Soc.* 1845); Owen, *Parthenogenesis*, and *Ann. N. H.* 1851, ii. 59; A. Thomson, *Cycl. An.* iv. *Suppl.*; Braun, *Rejuv., Ray Soc.* 1853; Henfrey, *Ann. N. H.* 2 ser. ix. 441; Radlkofer, *Befrucht.* 1857, *Ann. N. H.* 2 ser. xx. 241; Huxley, *Inv.* and *Verteb.*; Leuckart (*Cecidomyia larvæ*), *Ann. N. H.* xvii. 1866, 161; Sachs, *Bot.* 227; Nicholson, *Zool.* 1878, 33.

GENERATION, SPONTANEOUS; sometimes called equivocal generation, epigenesis, or heterogeny.

The doctrine of spontaneous generation was considered to have become a matter of history. We noticed under AIR (p. 24), the experiments which were supposed to have negatived the idea that microscopic plants and animals derive their origin from the direct transformation of decaying animal and vegetable remains. We have also there stated the modes by which the lower forms of organic life, most commonly found in decomposing infusions, propagate with extraordinary rapidity. More recent experiments have shown conclusively that this doctrine is untenable.

The supposed occurrence of particular species of Entozoa within the bodies of other animals, not to be found in any other situations, was formerly considered to find a ready explanation in the doctrine in question. Later investigations, however, have proved that these supposed species are larval or other forms of true species of this Class, which do not attain their perfect development on account of their not existing in a suitable locality.

BIBL. Schultz, *Pogg. Annal.* xli. 184; Helmholtz, *Jn. prak. Chem.* xxxi. 429; Gross, *Sieb. und Köll. Zeits.* iii. 68; Reissek, *Ber. Wien*, 1851; Pineau, *Ann. Sc. Nat., Zool.* 1845, 1848; Pasteur, *Compt. Rend.* 1860, li. 348, 675, and 1861, lii. 1142; Pouchet, *Hétérogénie*, 1859; id. *Nouv. Exp.* 1864; Bastian, *Beginnings of Life*, 1872; *Evolution of Life, Med. Press and Circular*, 1872; Tyndall, *Putrefaction*, 1881.

GENICULA'RIA, De Bary.—A genus of Desmidiaceæ.

Char. Cells cylindrical, elongate, neither constricted nor incised, united into long filaments. Endochrome forming 2 or 3 spirals (left-handed). Conjugating joints geniculate.

G. spirotænia (Pl. 51. fig. 36). Cells slightly expanded at the ends, cell-walls rough. Frankfort.

BIBL. De Bary, *Conjug.* 77; Rabenhorst, *Fl. Alg.* iii. 156; Pritchard, *Inf.* pl. 3. fig. 31.

GEO'DIA, Lamk.—A genus of marine sponges. Distinguished by the rounded form, the solid structure permeated by sinuous canals, and the solid external crustaceous covering formed of globules of silex.

G. Zetlandica. Deep water.

BIBL. Bowerbank, *Brit. Spong.* ii. 45.

GEOLOGY.—The microscopic investigation of geological products is treated of under ROCKS.

GEOPHI'LUS, Leach.—A genus of Chilopodous Myriapoda.

G. longicornis, with the body brownish-yellow, slender, consisting of more than 40 joints, is common in garden-mould, under flower-pots, &c. *G. subterraneus* is phosphorescent. See MYRIAPODA.

GEOR'GIA, Ehrh.—A genus of Mniaceous Mosses, called, from the four teeth of the peristome, *Tetraphis* and *Tetrodontium*; but these names are of later date than Ehrhart's (1780). *G. Mnemosyne* presents, besides its male and female inflorescence, a peculiar form of terminal leafy bud (fig. 278), which produces stalked gemmæ in the interior. In the figure, numerous archegonia are also shown.

Georgia Browniana, C. Müller, = *Tetraphis Brown.*, Grev.

G. Mnemosyne, Ehrh. = *Tetraphis pellucida*, Hedw.

Fig. 278.

Georgia Mnemosyne. A shoot with two terminal leafy buds. Magn. 15 diameters.

GEPHYR'IA, Arn.—A genus of Diatomaceæ.

Char.—Fr. arcuate, attached, destitute of cellulate annuli and septa; hoop sublamellate, finely striate. Valves arcuate, with one median and several lateral costæ, dissimilar; inferior with the costæ disappearing below the ends of the valve; superior with them reaching the summit.

G. incurvata. Ichaboe and Patagonian guano.

G. media. Californian guano.

G. Telfairiæ. Mauritius.

Bibl. Arnott, *Qu. Micr. Jn.* viii. 20; Greville, *Micr. Tr.* 1866, 77, 122 (fig.).

GERA'NIUM.—The sepals of the common wild Geraniums and the garden *Pelargonia* form pleasing objects when dried and mounted in Canada balsam, the cells containing regularly arranged raphides (Quekett, *Ann. N. H.* 1846, xviii. 82).

GER'DA, Cl. & L.—A genus of Infusoria, fam. Vorticellina.

Char. Sessile, resembling *Scyphidia*, but distinguished by the absence of the posterior sphincter or sucker.

G. glans (Pl. 52. fig. 2).—Body elongate, cylindrical or clavate behind; contractile vesicle posterior, continued into a long vessel. Freshwater.

Bibl. Clap. & Lachm. *Infus.* 117; Kent, *Inf.* 657.

GERMINAL VESICLE of Animals. See Ovum.

GERMINAL VESICLE of Plants.—This structure, the existence of which is now universally admitted by physiological botanists, is the germ of the future plant, formed from one of the protoplasmic *germ-masses* which exist before impregnation (Tulasne is doubtful whether before) in the embryo-sac of Flowering Plants. In most cases three masses are originally produced, as in *Orchis* (Pl. 47. fig. 4); and in rare instances two of these are fertilized, and two embryos produced in one seed; sometimes only one exists, and ordinarily only one is fertilized. This becomes at first elongated into a cellular filament called the *suspensor*, which is cut off by septa into several cells, the last of which usually becomes the *embryonal vesicle* or *embryo-cell*, which is then developed into the embryo (fig. 192, page 280). See Ovule and Embryo.

GERMINATION.—The act of development of a seed or spore into a new plant. The phenomena attending the germination of all the Cryptogamic plants require the aid of the microscope for their investigation, and are in most instances highly interesting and important in a physiological point of view. For particulars, see the classes of Flowerless Plants.

GER'RIS, Latr.—A genus of Hemipterous (Heteropterous) Insects, of the family Hydrometridæ.

Gerris lacustris is everywhere seen skimming the surface of water. It has the basal joint of the antennæ longest, the four hind legs very long and at a great distance from the fore legs. The legs do not possess any special structure by which they are enabled to repel the water, beyond a number of short hairs.

Velia rivulorum, with the basal joint of the antennæ longest, the legs of moderate length and equally apart, and *Hydrometra stagnorum*, with the first and second joints of the antennæ short, the third being the longest, are allied members of the same family, and are commonly met with on the surface of pools, &c. The elegantly sculptured eggs, and the curiously placed eyes of *Hydrometra*, are interesting objects.

In the anterior tarsi of *Velia*, minute membranous retractile lobes have been described.

Bibl. Westwood, *Introd.* ii. 467, and *Syn.* 119; Douglas and Scott, *Brit. Hemipt.*

GIGAR'TINA, Lamx.—A genus of Cryptonemiaceæ (Florideous Algæ), with cartilaginous irregularly-divided fronds, the internal substance of which is composed of rather lax tissue, the outer of dichotomous filaments perpendicular to the surface, strongly united by their moniliform terminations (fig. 279). Four British species are known, growing from 2 to 6 inches high, of a dull purple colour. Reproduced by spores (in favellidia) and tetraspores scattered among the peripheral filaments.

Fig. 279.

Gigartina pistillata.
Transverse section of the frond.
Magnified 50 diameters.

G. acicularis (Pl. 4. fig. 17).

Bibl. Harvey, *Mar. Algæ*, 139, pl. 17 C; Greville, *Alg. Brit.* 146, 147, pl. 16.

GILLS of Fishes.—These organs form beautiful and favourite injected objects. They must be injected from the heart, or from the branchial artery, which ascends

from the heart much in the same manner as the pulmonary artery ascends from the heart of the higher animals. It may be remarked that the heart of fishes is situated much nearer to the anterior end of the body than in the Mammalia.

Bibl. Stannius, *Vergl. An.*; Lereboullet, *An. Comp. de l'Appar. Respir.*; Hyrtl, *Med. Jahrb. Œster. Staat.* bd. 24; Leydig, *Histol.* 382; Gegenbaur, *Vergl. An.* 565.

GILLS of Insects, or branchiæ.—These are hair- or leaf-like processes (Pl. 35. figs. 2 *g*, 15, 19, 21) projecting from the surface of the body, and containing one or more tracheæ and their ramifications, which communicate with those of the body generally. Insects furnished with gills or branchiæ have no occasion to rise to the surface of the water in which they live, the diffusion by which the respiratory process is effected taking place between the gaseous contents of the tracheæ and those of the water.

GINAN'NIA, Montagne.—A genus of Cryptonemiaceæ (Florideous Algæ), containing one British species, *G. furcellata*, a rare, pinky-red sea-weed, about 2 to 6 inches long, with a dichotomous, terete, membranaceo-gelatinous frond, the divisions of which have a kind of fibrous axis. The spores are produced in spherical conceptacles imbedded just beneath the surface of the frond.

Bibl. Harvey, *Mar. Algæ*, 148, pl. 19 C; *E. Botany*, pl. 1881.

GINGER.—This substance finds a place here on account of its liability to adulteration when sold in the form of powder. It consists of the rhizomes of *Zingiber officinale* (N. O. Zingiberaceæ). The bulk of the structure consists of parenchymatous cellular tissue with pitted walls, containing scattered starch-granules, and here and there filled with a combined mass of starch-granules and yellow colouring-matter of very distinct character; besides these, occur the pitted ducts and a small quantity of woody fibre. The starch-grains nearly resemble those of the species of *Curcuma* which yield East-India arrowroot. Adulteration is effected with cheap starches (sago-, wheat-, or potato-flour), which may be detected by the form of the granules; while Mustard-husks and Cayenne pepper are employed to give pungency to the same reduced articles. The characters of these substances are given under their respective heads.

Bibl. Hassall, *Food &c.* p. 390.

GLANDS of Animals.—Glands are organs, the general function of which is to separate from the blood certain compounds destined to perform some special office in the economy. They are divided into true or secernent glands; and vascular glands.

The secernent glands, the secretions from which escape either by rupture, or through ducts, are thus arranged:—

1. Glands consisting of closed vesicles which dehisce laterally: the Graafian vesicles of the ovary, and the follicles (Nabothian) of the cervix uteri.

2. Glands composed of cells reticularly united: the liver. (See Liver.)

3. Racemose or aggregated glands, in which aggregations of roundish or elongated glandular vesicles occur at the ends of the excretory ducts. These are either, *a*, simple, with one or but few lobules, comprising the mucous glands, the sebaceous and the Meibomian follicles; or, *b*, compound, with many lobules, the lachrymal and salivary glands, the pancreas, the prostate, Cowper's and the mammary glands; in this category must also be placed the lungs.

4. Tubular glands, in which the secreting elements have a more or less tubular form. These are either, *a*, simple, consisting of one or but few cæcal tubes—including the tubular gastric and intestinal (Lieberkühn's), the uterine, sudoriparous and ceruminous glands; or, *b*, compound, consisting of numerous reticular or ramified glandular canals —comprising the testis and the kidney.

The vascular glands, which have no ducts, and the contents of which escape by transudation, are subdivided into—

1. Those composed of large and small cells imbedded in a stroma of connective tissue; comprising the supra-renal capsules, the anterior lobules of the pineal gland, and the pituitary body.

2. The closed follicles, consisting of a basement-membrane, an epithelial lining, and transparent contents, forming the thyroid gland.

3. The closed follicles, with a capsule of areolar tissue and contents consisting of nuclei, cells, and liquid, to which belong, *a*, the solitary follicles of the stomach and intestines; *b*, the aggregated follicles of the small intestines, or Peyer's glands, in animals also those of the stomach and large intestines; *c*, the glandular follicles of the root of the tongue, and of the pharynx and the tonsils; and, *d*, the lymphatic glands.

4. Here belongs the spleen, consisting of

a cellular parenchyma containing numerous closed follicles like the last.

5. The thymus gland, in which aggregated glandular vesicles open into a common closed canal or wide space.

The glands are further noticed under their respective heads.

BIBL. Kölliker, *Mik. An.*, and *Gewebelehre*; Henle, *Allg. An.*; Wagner, *Handw. Phys.*; Todd and Bowman, *Phys. Anat.*; Carpenter, *Physiol.*; Frey, *Histol.* 374.

GLANDS OF PLANTS.—The glands of plants are special structures formed of cellular tissue, in which are produced secretions of various kinds, such as oils, resins, &c. They are ordinarily more or less closely connected with the epidermal tissues, but not in all cases, the latter instances forming a kind of transition to the receptacles of special secretions, turpentine-reservoirs &c., found in the interior of the stems of many plants. Glands may be conveniently divided into *external* and *internal*: the former are sessile, or stalked (when they present the character of grandular *hairs*, of various forms); while the latter are generally visible externally as transparent dots scattered over an organ, such as a leaf, giving it the appearance of having been pricked all over with a pin; when of more considerable dimensions, and with thicker walls, they produce tuberculation of the surface, as on the rind of the orange, &c.

External glands. These may be subdivided into simple and compound.

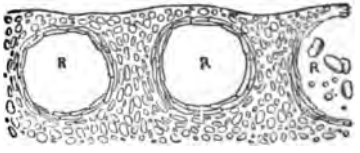
Simple external glands are either sessile vesicles or hairs, composed of a single vesicular or elongated epidermal cell filled with secretion; or they are hairs composed of a simple row of cells, one or more of which are filled with secretion. Examples of this may be found in the epidermis of *Primula sinensis, Gilia tricolor, Erodium cicutarium, Achimenes* (Pl. 28. fig. 32), *Stachys, Marrubium, Digitalis purpurea* (fig. 33), *Antirrhinum majus* (fig. 34), *Œnothera, Helleborus fœtidus, Scrophularia nodosa* (fig. 41), *Sempervivum, Salvia, Thymus, Mellissa, Mesembryanthemum*, Garden Chrysanthemum (fig. 30), &c.

The stings of the nettles are to be placed here; they consist of very long, tapering, single hairs, with an obtuse point, and a bulb-like expansion at the base, imbedded in a dense layer of epidermal tissue (Pl. 28. fig. 8). The hair is filled with the poisonous secretion. When the point touches the skin, it breaks off and allows the escape of the fluid contents, which are squeezed out by the pressure, and probably by the tension of the tissue around the bulb.

Compound external glands differ from the simple only in the fact that they are composed of a greater or a smaller number of cells combined into a mass, usually of spherical or allied form. They may be sessile, or stalked upon a simple or compound hair. Examples of *sessile* form occur in *Dictamnus albus* (Pl. 28. figs. 38, 39), *Robinia viscosa*, the leaf of the mulberry and the HOP (fig. 14), and the stipular glands of *Cinchona, Galium*, &c.; of the *stalked*, in the Rose (fig. 46), species of *Rubus, Drosera*, and on many aromatic or viscid plants.

Internal glands. These consist of cavities in the subepidermal tissue, of variable size, bounded by a firm layer of cells, and filled with oily or resinous secretions. They appear to be formed either of one cell, when small, or, when large, of a definite mass of cells, which, after the production of the secretion, have their walls obliterated so as to form a large chamber; possibly, however, some may be intercellular spaces into which the secretion is poured out. Examples of moderate dimensions are found in the leaves of *Dictamnus, Magnolia* (Pl. 28. fig. 12), *Hypericum perforatum*, and other species, *Myrtaceæ, Ruta graveolens* (fig. 11), &c. Very large glands of this kind contain the oil in the rind of the orange (fig. 280) and other species of *Citrus*.

Fig. 280.



Section of the rind of an orange, showing the internal glands, R, R.
Magn. 50 diams.

The *nectaries* of flowers have their tissue metamorphosed into a condition resembling that of the secreting part of glands; and the hairs of the stigma of Flowering Plants produce a secretion at the period of impregnation. Brongniart has lately pointed out the existence of internal glands in the dissepiments of the ovaries of the petaloid Monocotyledons. These structures form a transition to the turpentine-canals &c. of the Coniferæ. (See SECRETING ORGANS of Plants.) The *Gummi-Keulen* of Meyen

(*cystoliths* of Weddell) are also related to glands. (See RAPHIDES.)

Bennett draws attention to certain glands, imbedded in the leaves of *Drosera*, *Pinguicula*, and *Callitriche*, at first sight resembling stomata, with two papillæ. They are supposed to be related to a carnivorous function. Similar structures seem to exist in leaves of the garden rhubarb (Pl. 2. fig. 14).

BIBL. Meyen, *Secretionsorg. d. Pflanzen.* Berlin, 1857; Brongniart, *Ann. Sc. Nat.* 4 sér. ii. 5; Lawson, *Ann. N. H.* 2 ser. xiv. 161; Trécul, *Ann. Sc. Nat.* 4 sér. iii. 303; *Ann. N. H.* 2 ser. xvi. 146; Tieghem, *Ann. Sc. Nat.* 1872; Sachs, *Bot.* 92; Bennett, *M. M. Jn.* 1876, xv. 1.

GLANDULI'NA, D'Orb.—A Nodosarian Foraminifer. It has a free, regular, straight, ovoidal shell; globular, almost completely embracing chambers, the last being convex and prolonged; and a round, minute, terminal orifice.

G. lævigata (Pl. 23. fig. 28). Recent and fossil. Common in the Lias and Chalk.

BIBL. D'Orbigny, *For. Foss. Vien.* 28; Morris, *Br. Foss.* 36; Parker and Jones, *Ann. N. H.* 2 ser. xix. 280.

GLAUCO'MA, Ehr.—A genus of Infusoria, of the family Trachelina, E.

Char. Body ciliated all over; mouth longitudinal, oval, without teeth, placed laterally near the anterior third or fourth of the body, and furnished with one or two tremulous laminæ or lips.

Stein describes the encysting process as occurring in one species.

G. scintillans, E. (Pl. 31. fig. 8). Body colourless, slightly depressed, elliptical or ovate; sacculi large; length 1-290″. Freshwater, and in infusions (of hay, &c.).

G. viridis, D. Body green, oval; mouth large, nearer the middle than the anterior end of the body; length 1-630″. In putrid rain-water collected in an empty wine-cask coated with cream of tartar.

BIBL. Ehrenb. *Infus.* 334; Dujardin, *Infus.* 475; Stein, *Infus.* 250.

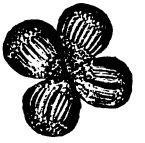
GLEICHENIA'CEÆ. — An order of Ferns, distinguished by the sori of few (2–10) obliquely annulated sporangia, which open vertically (fig. 282). Genera:

Gleichenia. Sporangia collected in roundish sori. Indusium absent. Leaves forking. Exotic (figs. 281 & 282).

Platyzoma. Sporanges collected in point-like sori. Indusium spurious, formed by the revolute margin of the leaf. Leaves undivided.

Fig. 281.

Fig. 282.



Gleichenia.

Fig. 281. Fertile pinnules with sori. Magn. 5 diams.
Fig. 282. Sorus composed of four crucially arranged capsules. Magn. 40 diams.

GLENODIN'IUM, Ehr.—A genus of Infusoria, of the family Peridinæa.

Char. Carapace membranous, rounded or oblong, with one or more distinct furrows furnished with vibratile cilia; an elongated or horse-shoe-shaped red (eye-) spot present; no horn-like processes.

These organisms are doubtful Infusoria. They are common in pools and bog-water.

G. cinctum (Pl. 31. fig. 10 *a*, *b*). Ovate or subglobose, ends obtuse, yellow; carapace smooth; eye-spot large, transverse and semilunar; length 1-576″.

G. apiculatum (Pl. 31. fig. 10 *c*). Oval, ends obtuse, greenish yellow; carapace smooth; eye-spot oblong; length 1-480″.

G. tabulatum. Oval, greenish yellow; carapace granular, reticulated with prominent lines; ends acute or denticulate; eye-spot oblong; length 1-480″.

BIBL. Ehrenberg, *Inf.* 257; Dujardin, *Inf.* 373; Kent, *Inf.* 446.

GLENOM'ORUM, Ehr.—The *Glenomorum tingens* of Ehrenberg (Pl. 31. fig. 14), which consists of aggregated revolving groups of green bodies, with two anterior cilia, and a red (eye-) spot, has been shown by Weise and Stein to form the young state of CHLOROGONIUM, which itself appears probably to be a stage of development of PROTOCOCCUS.

GLENOPH'ORA, Ehr.—A genus of Rotatoria, of the family Ichthydina.

Char. Free; eyes two, frontal; rotatory organ circular and frontal; tail truncated, without toes.

G. trochus (Pl. 43. fig. 36). Body ovato-

conical, colourless, the turgid front and the narrowed foot truncated; eyes blackish; length 1-576″; freshwater.

Bibl. Ehrenb. *Infus.* p. 391.

GLENOS'PORA, Berk. & Desm.—A genus of Dematiei (?) (Hyphomycetous Fungi), of which one species (*G. Thwaitesii*) appears to have been found in Britain.

Bibl. Berk. *Hort. Journ.* iv. p. 256.

GLOBIGERI'NA, D'Orb. — A typical Foraminifer. The shell is minute and globose, consisting of a series of ten or fewer globular chambers, arranged spirally in two or three whorls, and increasing rapidly from 1-2000 to 1-80″ in diameter. Surface foraminated and rugose, sometimes prickly. Each chamber opens into the umbilical hollow by a crescentic orifice. In *G. cretacea* and *G. hirsuta* the shell is almost discoidal and nautiloid; in *G. bulloides* (Pl. 24. figs. 2, 3) the chambers become heaped; in *G. helicina* the later chambers expand and grow irregular. In some cases the last chamber overlaps all the others, and the shell becomes an *Orbulina*.

G. bulloides is very abundant in the Atlantic and other oceans, also in the shallow water of the Adriatic. Many varieties occur, recent and fossil, from the Triassic period to the present day.

Bibl. Wallich, *Biolog. Globig.* 1876; Carpenter, *For.* 181; Parker and Jones, *Phil. Tr.* 1865, 365; Brady, *Mic. Jn.* 1879, 70.

GLOBULI'NA, Turp. = Glœocapsa.

GLOBULI'NA, D'Orb. See Polymorphina.

GLŒOCAP'SA, Kütz.—A genus of Palmellaceæ (Confervoid Algæ), distinguished by the rounded cells, single or grouped into families, with special and general lamellar envelopes. As we have adopted it, it is distinguished from *Palmella* by the persistence of the coats of the parent-cells as envelopes enclosing their progeny of several generations, to the number of 4, 16, 64, or more secondary cells, the membranes becoming confluent subsequently, however, by solution, into a gelatinous mass. From *Coccochloris* the chief distinction seems to be in the persistence of the lamellæ of the parent cells in the membranous condition, and the globular instead of cylindrical or elliptical form of the cells, while the habit is to form rather flat irregular strata than globose or papillose masses. From *Protococcus* it is distinguished by the persistent gelatinous investment. Some recent writers, especially Sachs, assume that the species of *Glœocapsa* are early stages of development of Lichens, from gonidia.

G. confluens. Stratum gelatinous, green. Diam. of cell-contents, 1-1200 to 1-600‴. = *Hæmatococcus minutissimus*, Hassall?

G. montana. Stratum gelatinous, green; vesicles concentrically striated; cell-contents 1-1000 to 1-500‴ in diam. = *H. microsporus*, Hass.

G. granosa. Stratum green, firm; vesicles concentrically striated; cell-contents 1-300‴ in diam. = *H. granosus*, Hass.

G. polydermatica (Pl. 7. fig. 4). Stratum hardish, olivaceous, somewhat compact or granular; concentric lamellæ evident, thick; cell-contents 1-800 to 1-500‴ in diam. = *H. rupestris*, Hass.

G. æruginosa. Stratum grey-æruginous, granular-crustaceous; vesicles large (1-100 to 1-60‴), irregular; cell-contents 1-1000 to 1-600‴. = *H. æruginosus*, Hass.

G. lividia. Stratum dirty olive or blackish, soft, but tubercular; cell-contents æruginous; 1-700‴. *H. lividus*, Hass.

G. Magma. Stratum purpliah-black, crustaceous, granular; cell-contents 1-500 to 1-320‴. *Sorospora montana*, Hass.

G. sanguinea. Stratum black; internal cells deep blood-red; cell-contents 1-600 to 1-400‴. = *Hæmatococcus sanguineus*, Ag., Hass.

G. Shuttleworthiana. Stratum dirty red; internal cells orange; cell-contents 1-1000 to 1-900‴.

G. Ralfsiana. Stratum dirty purple; internal cells rosy-purple; cell-contents 1-750 to 1-400‴. = *Sorospora Ralfsii*, Hass.

In Pl. 7. fig. 13 is represented a form we have met with among freshwater Algæ, which appears to agree with Kützing's *G. ampla*.

Those resting forms of *Euglena* where the encysted groups are devoid of a firm outer coat, bear considerable resemblance to a large *Glœocapsa*.

Rabenhorst describes 55 European species.

Bibl. Kützing, *Phyc. gen.* 173, *Sp. Alg.* 216, *Tab. Phyc.* pls. 19 *et seq.*; Hassall, *Algæ*, pl. 79, &c.; Sachs, *Bot. Zeit.* xiii. 1; Al. Braun, *Rejuv.* (*Ray Soc.* 1853), 131, 182; Rabenhorst, *Fl. Alg.* ii. 34.

GLŒOCOC'CUS, Braun.—A genus of Palmellaceæ, consisting of active biciliated gonidia resembling the moving form of *Protococcus*, but connected into families by a mass of soft jelly. See Palmellaceæ.

Bibl. A. Braun, *Verjüngung*, 169: *Chytridien*, 57; Rabenhorst, *Fl. Alg.* iii. 36 (fig).

GLŒOCYSTIS, Nägeli = *Glœocapsa*, pt.

GLŒOSPO'RIUM, Montagne.—A genus of Sphæronemei (Stylosporous Fungi), developed beneath the surface of leaves, and bursting through, forming a kind of rust on the surface.

G. paradoxum (*Myxosporium paradoxum*, De Notar.) occurs on ivy.

G. Labes. Asteroma Labes, Berk. *Brit. Fungi.*

G. concentricum (*Cylindrosporum concentricum*, Grev. *Sc. Crypt. Flor.* p. 27) forms a white rust upon cabbage-leaves.

Bibl. Berk. & Br. *Ann. Nat. Hist.* 2 ser. v. p. 455; Berkeley, *Hort. Trans.* vi. p. 121.

GLŒOTHE'CA, Näg.—A genus of Palmellaceæ (Confervoid Algæ), distinguished by the oblong or cylindrical cells, with thick, often lamellar envelopes.

13 species; on humid rocks (Rabenhorst, *Fl. Alg.* ii. 60).

GLŒO'TILA, Kütz.—A genus of Confervaceæ with simple, submoniliform filaments, endochrome of the cells becoming contracted and rounded. Ten species. Freshwater; in ditches and aquaria. (Rabenhorst, *Fl. Alg.* iii. 319.)

GLOIOSIPHO'NIA, Carm.—A genus of Cryptonemiaceæ (Florideous Algæ), the single British representative of which is a rare, feathery, red sea-weed, 3–12 inches high, with a semigelatinous tubular frond. The spores are in dense masses, scattered among the radiating jointed filaments which clothe the periphery of the branches.

Bibl. Harvey, *Mar. Alg.* 152, pl. 21 A, *Eng. Bot.* pl. 1219.

GLYCERINE is the sweet principle of fats. It may be prepared by boiling fats with oxide of lead and water. The aqueous solutions are freed from the lead by sulphuretted hydrogen, the filtered liquid evaporated to the consistence of a syrup, and finally *in vacuo* over sulphuric acid. It is now procured by decomposing the fats with high-pressure steam.

Glycerine, when pure, is a colourless, highly refractive, syrupy liquid, of a sweet taste; it mixes in all proportions with alcohol and water, but it is insoluble in ether. The property possessed by glycerine, of constituting a liquid which does not become dry, and mixes with water, renders it very useful for the preservation of microscopic objects; especially those which will not permit of being dried, such as preparations of vegetable structure, which may be left on a slide in a drop of glycerine, with a glass cover to exclude dust, for weeks and months without alteration. It renders objects very transparent, which is sometimes advantageous, sometimes the reverse. A solution of gum-arabic in diluted glycerine is often used for mounting objects which do not bear drying. The solution is made by dissolving 1 oz. of very clear gum in 1 oz. of water, and adding subsequently 1 oz. of glycerine: great care must be taken, in incorporating the glycerine, to avoid forming air-bubbles, which are difficult to get rid of on account of the viscidity of the fluid. The mode of mounting objects is to soak them in pure glycerine, and then to operate as with Canada balsam, only not applying heat.

GLYCIPH'AGUS, Hering.—A subgenus of Acarus, p. 8.

GLY'PHIS, Ach.—A genus of Graphidei (Lichenaceous Lichens).

G. labyrinthica, on trees, very rare. (Leighton, *Lich.-Flora*, 436.)

GLYPHODES'MIS, Grev.—A genus of Diatomaceæ.

Char. Fr. united into a filament; side view naviculoid, with a central nodule, median line, and transverse rows of granules; structure clathrate (?), the granules being developed within square areolæ, arranged in parallel rows.

G. eximia. In scrapings of marine shells. Jamaica.

Bibl. Greville, *Qu. Mic. Jn.* 1862, 234 (figs.).

GLYPHODIS'CUS, Grev.—A genus of Diatomaceæ.

Char. Fr. four-sided, the angles much rounded. Valves with a large 4-angled nucleus, the angles alternating with those of the margin; and a circular prominent process within each marginal angle, from which costæ radiate to the nucleus; while similar costæ radiate from the angles of the nucleus to the sides of the disk.

G. stellatus. Monterey stone.

Bibl. Greville, *Mic. Tr.* 1862, 91.

GLYPHOMIT'RIUM, Bridel.—A genus of Orthotrichaceous Mosses, deriving its name from the grooved calyptra. *Glyphomitrium Daviesii*, Brid., is found in Wales and Ireland on rocks, mostly near the sea. It is peculiar to Great Britain and Ireland.

GNAT. See Culex and Culicidæ.

GNETA'CEÆ.—An order of Flowering Plants, remarkable for their jointed stems, composed of ducts and wood-cells marked like the wood of Conifers. The rind and

Fig. 283.

Glyphomitrium Daviesii.
Teeth of the peristome. Magnified 150 diams.

pith, also, contain curious branched liber-cells.

GOMPHIL'LUS, Nyl.—A genus of Lichenaceous Lichens.

G. calycioides. On mosses, rare. (Leighton, *Lich.-Flora*, 50.)

GOMPHOGRAM'MA, Braun.—A genus of Diatomaceæ, cohort Fragilarieæ.

Char. Frustules solitary or geminate, front view tabellar, with interrupted clavate longitudinal vittæ, ends internally dentate; valves ovate or elliptic-lanceolate, with transverse continuous costæ.

G. rupestre (Pl. 52. fig. 3). On moist rocks (freshwater).

Bibl. Rabenhorst, *Fl. Alg.* i. 116; and p. 12 (fig.).

GOMPHONE'MA, Ag.—A genus of Diatomaceæ.

Char. Frustules mostly single or binate, attached by a filiform stipes, wedge-shaped in front view; valves with a median line and a nodule at the centre and at each end, and striated with transverse or slightly radiating granular striæ. Freshwater and fossil.

Conjugation has been observed in several species.

Kützing describes thirty-eight species; Smith admits twelve as British. The form of the frustule is subject to great variety; and the specific characters are probably of little value.

The most common species are:—

G. acuminatum (Pl. 16. fig. 34 *a*, *b*, *c*). Frustules in front view simply cuneate, or inflated in the middle; valves attenuated at the base, ventricose in the middle, beyond which they are again expanded; ends acuminate, or truncate with an acuminate prolongation; striæ distinct; length of frustules 1-360". San Fiore deposit.

G. geminatum. Valves ventricose in the middle, constricted and rotundo-truncate towards each end; striæ distinct; stalks long, thick, densely interwoven; length of frustules 1-216 to 1-180".

G. olivaceum. Densely crowded, forming a mucous mass; frustules broadly cuneate (fr. v.); valves obovato-lanceolate; striæ distinct; length of frustules 1-1020".

G. curvatum. Frustules curved; valves obovato-lanceolate; striæ faint; length 1-720".

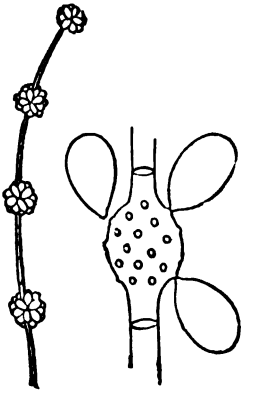
Bibl. Ehr. *Infus.* 215; Kützing, *Bacill.* 84, and *Sp. Alg.* 63; Smith, *Br. Diatom.* 76; Ralfs, *Ann. N. H.* 1843, xvi. 459.

GOMPHOSPHÆ'RIA, Ktz.—A genus of Palmellaceæ; with the cells radiating, and united into groups in a globose mucous envelope.

G. aponina. In pools. (Rabenhorst, *Fl. Alg.* ii. 55.)

GONATOBO'TRYS, Corda.—A genus of Mucedines (Hyphomycetous Fungi), the fer-

Fig. 284. Fig. 285.



Gonatobotrys simplex.
Fig. 284. A fertile filament. Magn. 100 diams.
Fig. 285. A sporiferous joint, with most of the spores removed. Magn. 600 diams.

tile filaments of which present at intervals swollen articulations, on which are attached simple ovate spores (figs. 284, 285).

Bibl. Corda, *Icones Fungorum.*

GONATOR'RHODON, Corda.—A genus of Mucedines (Hyphomycetous Fungi), the fertile filaments of which have at intervals swollen articulations, whence arise moniliform chains of spores (fig. 286).

Bibl. Corda, *Prachtfl. europ. Schimmelb.* pl. 3.

GONATOZY'GON, De Bary.—A genus of Diatomaceæ.

Char. Cells cylindrical or truncate-fusiform, neither constricted nor incised, united

into long fragile filaments; endochrome simple, undulate and twisted. 2 species; freshwater.

G. Ralfsii (Pl. 51. fig. 37).

Bibl. Rabenhorst, *Flor. Alg.* iii. p. 155.

GONGROSI'RA, Ktz.—A genus of Chætophoraceæ (Confervoid Algæ).

Fig. 286.

Gonatorrhodon speciosum.

Fertile filaments with swollen joints bearing chains of spores. Magn. 100 diams.

Filaments jointed, sub-dichotomously branched or tufted, attenuated at the base to form a root-like thread; joints as long or twice as long as broad, torulose. Four species; minute; on stones, wood, and aquatic plants. (Rabenhorst, *Fl. Alg.* iii. 387.)

GONID'IA.—The name applied to cells which in the Thallophytes perform an office analogous to that of the Gemmæ of the higher Cryptogams, and the separating bud-structures such as bulbils, stolons, &c. of the Flowering Plants,—being cells developed from the vegetative tissues, ultimately thrown off, and capable of propagating the individual. The gonidia of the Lichens are globular cells with green contents, developed in the central layers of the thallus, afterwards set free by the destruction of the cortical layer; they appear capable of multiplication by subdivision before growing out into the filaments which form the foundation of the new thallus (see Lichens). And the endochrome has lately been observed in a few Lichens to be resolved into zoospores, a circumstance which brings Lichens in an important point still nearer to Fungi. The gonidia of the Fungi are usually termed Conidia (see that article, and Fungi). The gonidia of the Algæ are best known in the Confervoids, where they are formed from the cell-contents, and generally present themselves ciliated, as Zoospores. The tetraspores of the Floridese are probably the homologues of gonidia.

GONIO'COTES, Nitz.—A subgenus of *Philopterus*, like *Goniodes*, but the antennæ alike in both sexes.

G. hologaster, on the fowl.

GONIOCY'PRIS, B. & R.—A minute Ostracode, with yellowish, compressed, triangular valves; found in the rivers and dykes of Eastern England.

Bibl. Brady and Robertson, *Ann. N. H.* 1870, vi. 15.

GONIO'DES, Nitzsch.—A subgenus of *Philopterus* (Anoplura), distinguished by the large head, with projecting temporal angles, no trabeculæ; antennæ forcipate in the males, cylindrical in the females. Several species, on the turkey, the guinea-fowl, the domestic fowl, the pheasant, and the grouse.

GONIOM'ONAS, St.—A genus of Flagellate Infusoria.

Char. Free, or adherent posteriorly; flagella two, equal, obliquely truncate in front.

G. truncata. Freshwater. (Kent, *Inf.* 280.)

GONIONE'MA, Nyl.—A genus of Byssaceous Lichens.

G. velutinum. On subalpine rocks; rare. (Leighton, *Lich. Fl.* 9.)

GONIOTHE'CIUM, Ehr.—A genus of fossil Diatomaceæ.

Char. Frustules terete, with a median (longitudinal) constriction (suddenly attenuate and truncate at the ends, hence appearing angular).

Corresponds to *Pyxidicula*, constricted in the middle, and truncate at the ends.

Found in America.

We have figured several of the nine or ten species, some of which do not appear to have the characters of the genus.

G. Anaulus (Pl. 51. fig. 18); *G. barbatum* (fig. 19); *G. didymum* (fig. 20); *G. monodon* (fig. 21); *G. navicula* (fig. 22); *G. Rogersii* (fig. 23); *G. gastridium* (Pl. 50. fig. 40); *G. odontella* (fig. 44).

Bibl. Ehrenberg, *Abh. Berl. Ak.* 1841, 401, *Berl. Ber.* 1844, 82, and *Mikrogeol.*; Kützing, *Bacill.* 51, and *Sp. Alg.* 23; Greville, *Mic. Tr.* 1865, 56.

GO'NIUM, Müller.—A genus of Volvocineæ (Confervoid Algæ), forming microscopic, square, flat fronds, either ciliated and endowed with a power of motion, or devoid of cilia and motionless; it is possible that these two conditions are only stages of development in species active at one time and resting at another. The perfect fronds are composed of usually sixteen cells, enclosed in wide colourless coats (young fronds but four cells, some kinds have more than sixteen) united together into flat square masses by adherence at various points of their cir-

cumference. A light vacuole in the substance of the cell-contents may often be observed to exhibit a rhythmical contraction and expansion, as in *Volvox*. The cells of the active forms have each a pair of vibratile cilia, which run out from the central protoplasmic mass, through the hyaline envelope, and project as free processes, rowing the frond about in the water. They are commonly observed to increase by division, a frond composed of sixteen cells breaking up into four fronds, each composed of four cells, &c.; but it is probable that other kinds of development exist, and that the motionless forms are *resting* states of active species. *Gonium pectorale* is an exceedingly interesting microscopic object, not uncommon in freshwater pools.

G. pectorale (Pl. 7. fig. 11). Frond square, composed of sixteen bright-green cell-masses enclosed in hyaline envelopes, each with a pair of cilia; size of green masses 1-1960 to 1-1150″; frond not exceeding 1-280″. In clear water, salt and fresh, near the surface.

G. punctatum. Cells sixteen; cell-masses green, with black granules; diam. 1-4600″; frond of sixteen, 1-576″.

G. tranquillum (Pl. 7. fig. 12). Cells sixteen; cell-masses green, diam. 1-2880″; frond of sixteen, 1-144 to 1-288″, sometimes twice as broad as long; the cell-masses found in division (binate or quaternate), motionless. (Possibly not a *Gonium*, but a Palmellacean—*Tetraspora* ?).

G. hyalinum. Cell-masses hyaline, diam. 1-3000″; frond of twenty or twenty-five, 1-600″. In stagnant water.

G. glaucum. Cell-masses bluish green, from four to sixty-four in a frond, diam. 1-7000 to 1-4200″, ditto of frond not exceeding 1-570″. In sea-water.

Bibl. Ehrenberg, *Inf.* 55; Cohn, *Nova Acta*, xxiv. 169, pl. 18; Fresenius, *Mus. Senckenb. Gesell.* ii. 187, 1856.

GONOTHYRÆ'A, Allman.—A genus of Campanulariidæ, Hydroid Zoophytes. 2 species.

G. Loveni (*Laomedia dichotoma*, Johnson), on the fronds of the large sea-weeds, and on stones, at low-water mark.

Bibl. Hincks, *Hydroid Zooph.* 180.

GOR'DIUS, Linn.—A genus of Nematoid Entozoa.

Char. Body very long and slender, filiform; alimentary canal (none, Vill.) with a single orifice, sexes distinct.

G. aquaticus, the common hair-worm, is from 7 to 10″ in length and about 1-25 to 1-20″ in breadth, of a brown or blackish colour, and is found in water or damp places. The mouth is very indistinct; the tail of the male is bifid, that of the female simple and rounded.

The ova, agglutinated in long strings, are deposited in water, and being devoured by insects or Arachnida, undergo development within their bodies.

These animals frequently coil themselves into a knot-like form, whence the name.

See Mermis.

Bibl. Dujardin, *Helminth.* 296, and *Ann. Sc. Nat.* 1842, xviii. 142; *Ent. Zeit.* 1842–43, and Erichson's *Archiv*, 1843, ii. 302; Berthold, *Bau d. Wasserkalbes*, 1842; Meissner, *Sieb. & Köll. Zeits.* 1856, i.; Siebold, *ibid.* 141; Grenacher, *Sieb. & Köll. Zeitsch.* 1868; Villot, *Ann. N. H.* 1872, x. 231; *Compt. Rend.* 1880, 1569; *Ann. N. H.* 1880, vi. 169.

GORGO'NIA, Linn.—A genus of marine Polypi, of the order Actinoida, and family Gorgoniadæ.

Char. Polypidom rooted, and consisting of a central, branched, horny, and sometimes anastomosing flexible axis, coated with a soft and fleshy polypiferous crust.

The species are popularly known as sea-fans; they are not microscopic, often attaining very considerable dimensions.

The polypidom, as well as the crust, contains spicula of various forms imbedded in them, a specimen of which is exhibited in Pl. 41. fig. 27.

Bibl. Johnston, *Brit. Zooph.* 166; Kent (spicules), *M. M. Jn.* 1870, 76; Gosse, *Actinologia.*

GOSSYPIUM. See Cotton.

GOUT-STONES. See Chalk-stones.

GRACILA'RIA, Grev.—A genus of Rhodymeniaceæ (Florideous Algæ), with feathery fleshy-cartilaginous fronds, 3 to 12″ or more long, of a red or purplish colour, the central substance of which is composed of large cells, the cortical of closely packed horizontal filaments. The spores are formed in tubercles consisting of a thick coat composed of radiating filaments, containing a mass of minute spores on a central placenta. The tetraspores are imbedded in the cells of the surface. *G. confervoides* is the only common species; it grows from 3 to 20″ long, and as thick as small twine.

Bibl. Harvey, *Br. Mar. Alg.* 128, pl. 16 C; *Engl. Bot.* pl. 1668.

GRAMMATONEMA, Ag.—A genus of

microscopic marine plants, by some referred to the Diatomaceæ, by others, including Ralfs and Kützing, to the Desmidiaceæ.

The recent observations of Smith show that it belongs to the former family, and to the genus *Fragilaria*.

G. striatulum = *Fr. striatula*.

GRAMMATOPH'ORA, Ehr.—A genus of Diatomaceæ.

Char. Frustules in front view rectangular, at first adnate, but afterwards forming zigzag chains; vittæ two, longitudinal, interrupted in the middle and more or less curved. Marine.

Valves linear or elliptical; furnished with transverse striæ, in most, invisible by ordinary illumination, and in a few so difficult of detection that the valves have been regarded as TEST OBJECTS. Sometimes a median and terminal nodules are present.

Rabenhorst describes eleven species. Four are British; one doubtful:—

G. marina (Pl. 1. fig. 14; Pl. 16. fig. 35). The markings or striæ are invisible by ordinary illumination; vittæ near the middle semicircularly curved outwards; valves linear or elliptical, gradually attenuated towards the obtuse ends; striæ transverse; length 1-108 to 1-240″.

The form and structure of the frustules and valves appear greatly to vary. Sometimes the frustules are perfectly square, at others six times as long as broad. In some specimens the valves are suddenly, at others uniformly inflated at the middle (Pl. 1. fig. 14 *b*; Pl. 16. fig. 35 *c*), some have the ends capitate. Again, in some valves there is a median line and a small central nodule (Pl. 16. fig. 35 *c*); in others there is neither median line nor nodule, but a large internal ring (Pl. 1. fig. 14 *b*). Lastly, in some valves the striæ extend over the whole of the valves, while in others they are deficient at their ends. Some of these variations have formed the basis of distinct species, but probably with little reason.

A variety, *G. subtilissima*, Bail. (Pl. 1. fig. 15 *a*, *b*), has been pointed out by Prof. Bailey, in which the form of the frustules and valves agrees with the above characters, but in which the transverse striæ are extremely difficult of detection when mounted in balsam.

G. macilenta. Fr. slender, often curved; vittæ as in the last; valves linear, slightly inflated at middle and ends. Marine; length 1-300″.

G. serpentina. Vittæ long, serpentine, with the end curved inwards to form a kind of hook; striæ oblique. Marine; length 1-200″.

G.? Balfouriana. Vittæ straight; valves linear, inflated in the middle, and with rounded ends. Freshwater.

BIBL. Ehrenberg, *Berl. Abh.* 1839, 126, and *Ber.* 1840, &c.; Kützing, *Sp. Alg.* 120; Bailey, *Silliman's Journ.* vii.; Smith, *Br. Diat.* ii. 42; Schiff, *Schultze's Archiv*, iii. 81; Rabenhorst, *Fl. Alg.* i. 303; Petit, *Jn. Mic. Soc.* 1881, i. 109.

GRAMMITID'EÆ.—A family of Polypodiaceous Ferns.

Char. Sori on the back of the fronds, more than twice as long as broad, usually linear. Genera:

Jamesonia. Sori oblong, on the flabellate veins of the back of the pinnæ, not reaching the margin.

Brainea. Sori continuous along transverse veins near the midrib, also produced along the veins towards the edge of the frond.

Notochlæna. Sori marginal, oblong or rounded, then confluent into a marginal line, the edge of the frond frequently inflexed to form an involucre; veins free.

Monogramma. Sori linear, close to the midrib on one or both sides.

Gymnogramma. Sori on the veins of the under surface of the frond, linear, simple or forked.

Meniscium. Sori oblong or linear, occupying the connivent transverse veinlets of the simple or once pinnate fronds.

Antrophyum. Sori on the veins, imperfectly reticulated.

Vittaria. Sori in continuous marginal or slightly intramarginal lines.

Tænitis. Sori linear, the line sometimes interrupted, central or submarginal.

Drymoglossum. Like *Tænitis*, but the fronds dimorphous.

Hemionitis. Sori continuous along the veins, and copiously reticulated, sometimes also slightly developed between them.

GRAMMI'TIS, Swartz., is merged into *Polypodium* and *Gymnogramma*. *Ceterach* is sometimes taken for a *Grammitis*.

GRAMMONE'MA, Ag. = GRAMMATONEMA.

GRAN'TIA, Fleming.—A genus of Sponges.

Char. Form variable; firmish and inelastic, usually white, with a close but porous texture, and composed of a gelatinous base, with imbedded calcareous spicula; orifices distinct. Marine.

Spicula simple, radiate or stellate, composed of carbonate of lime; hence easily distinguished from the siliceous spicula of other sponges by their dissolving with effervescence in a dilute acid. The organic basis is stated not to be fibrous as in most other sponges.

The British species are found growing upon or from rocks, sea-weeds, shell-fish and zoophytes, between tide-marks. They vary in size from about the 1-10 to 3 or 4″. Gemmules have not been found.

Bibl. Johnston, *Br. Sponges*, 172; Grant, *Compar. Anat.* and *New Phil. Journ.* i. and ii.; Bowerbank, *Br. Spong.* ii. 1.

GRANULE-CELLS.—This term has been applied to cells found in animal solids and liquids containing a number of globules of fat or oil (Pl. 38. figs. 7, 16 *a*, 17 *e*). They are of variable size, perhaps the average may be placed at 1-2000″; and are easily recognized by the dark margins and light centres of the globules, which are insoluble in acetic acid and solution of potash. The cells sometimes contain a nucleus, at others not. The term granule-cells should properly be limited to cells of new formation, as those found in inflammation, cancer, &c.; but it has been so generally applied to cells of whatever kind, containing fatty globules, that it has no pathological signification.

See Degenkration, Fatty, and Inflammation.

GRANULOSE. See Starch.

GRAPE-FUNGUS. See Oidium.

GRAPHID'EI.—A tribe of Lichenaceous Lichens, having a thin, crustaceous, scarcely visible or subepidermal thallus, with lirelline apothecia.

It includes the British genera: *Agyrium*, *Arthonia*, *Chiodecton*, *Glyphis*, *Graphis*, *Lithographa*, *Melaspilea*, *Opegrapha*, *Platygrapha*, *Ptychographa*, *Stigmatidium*, and *Xylographa*.

Bibl. Leighton, *Brit. Lichen-Flora*, 390.

GRA'PHIS, Ach.—A genus of Graphidei, containing ten British species, very variable in their appearance; mostly whitish or yellow papery expansions on the bark of trees, beset with irregular black markings (lirelline apothecia) like writing.

Bibl. Leighton, *Brit. Lich.-Fl.* 426.

GRASSES.—A family of Monocotyledonous Flowering Plants, remarkable in many respects for their microscopic structure, especially the siliceous Epidermis and the Starch grains in the Albumen, for which see those heads.

GRATELOU'PIA, Ag.—A genus of Cryptonemiaceæ (Florideous Algæ), represented by a very rare British species, *G. filicina*, seldom growing more than 2 inches high with us. Fructification minute, immersed, favellidia opening by a pore, and cruciate, tetraspores vertically placed among the filaments of the periphery.

Bibl. Harv. *Mar. Alg.* 137, pl. 17 A; Grev. *Alg. Brit.* pl. 16.

GREENSAND.—According to the observations of Ehrenberg and Bailey, the glauconitic grains frequent in many geological deposits, especially in certain beds known as Greensand, are formed of fossilized organic bodies, mostly casts of Foraminifera.

Bibl. Ehrenberg, *Abh. Berl. Akad.* 1856, 85–176; *Monatsber.* 1858, 328; Bailey, *Ann. N. H.* s. 2. xviii. 425; Parker & Jones, *Ann. N. H.* s. 4. x. 263; Sollas, *Geol. Mag.* 1876, 539.

GREGARI'NA, Dufour.—This curious group of organisms, which was formerly placed among the Entozoa, is now placed among the Protozoa, forming the Order Gregarinida; but there are still doubts as to their structure and nature.

They exist as parasites within the bodies of animals, and often inhabit the intestinal canal, or the cavity of the abdomen. Most frequently they are met with in insects, especially their larvæ; but sometimes also in Annelida, both freshwater and marine (*Lumbricus* &c.), in the Crustacea and Mollusca; and even in human organs.

They are mostly microscopic, and colourless; round, oval, fusiform, or cylindrical (Pl. 21. figs. 25, 28, 34); and consist of a smooth transparent cell-wall, enclosing a granular, more or less liquid mass, with one or more nuclei or nucleoli. Sometimes they exhibit a constriction in the middle, or are divided by a transverse septum. In some a process resembling a head is situated at one end; this may be short, round, and obtuse or pointed, or more elongated and furnished with reflexed hook-like processes. The *Gregarinæ* are capable of motion, which is either that of slow progression, ensuing without contraction of the body, or produced by irregular contraction of the membrane or substance of the body.

Vibratile cilia have been detected both upon the outer and the inner surface of the membrane; and the internal granules often exhibit molecular motion, especially after the addition of water. One or more long

motionless filaments sometimes arise from the outer surface.

The membrane and its contents, except the nucleus, are soluble in acetic acid.

Their method of propagation, if such it is, represents a form of conjugation, and takes place as follows. Two individuals coming into contact by corresponding portions of the body (Pl. 21. fig. 34), become shortened and firmly united. A transparent capsule is next formed around them, which encloses them in a cyst (figs. 26, 30), the adjacent portions of the cell-membranes are absorbed, and the substance of the two bodies become intimately fused. Globules or cells are then formed in the contents of the cell, which subsequently assume the form of *Naviculæ*, and have been called pseudo-naviculæ (erroneously *navicellæ*: figs. 31, 32, 33); these burst, producing Amœbiform bodies, which develop into new *Gregarinæ*.

It was supposed that the pseudo-naviculæ were really *Naviculæ*, and that the cysts containing them were sporangia; but the pseudo-naviculæ do not possess a coat of silex.

In some cases it appears that the contents of the two cells in conjugation remain distinct until the pseudo-naviculæ are formed; but it is not certain whether each single cell in these instances has not arisen from the fusion of two others.

A very large number of species of *Gregarina* have been described and arranged in numerous genera.

Bibl. Dufour, *Ann. Sc. Nat.* 1837, vii.; Stein, *Müller's Arch.* 1848; *Ann. N. H.* 1850, v., and *Infus.*; Frantzius, *Gregar.* 1846; Henle, *Müller's Archiv*, 1835, 1845; Siebold, *Naturg. d. wirbellos. Thiere*, 1839; Kölliker, *Sieb. & Kölliker's Zeitschr.* 1848 & 1849; Ray Lankester, *Qu. Mic. Jn.* 1863, iii. 83, and *Mic. Tr.* 1866, 23 (Pl.); V. Beneden (*G.* of lobster), *Bull. l'Acad. d. la Belgique*, 1869 (*M. M. J.* 1870, 47), and *Ann. N. H.* 1872, x. 309.

GRIFFITH'SIA, Ag.—A genus of Ceramiaceæ (Florideous Algæ), with feathery fronds 3 to 6″ long, composed of delicate dichotomously-branched filaments consisting of a single row of cells, the branchlets often whorled; colour crimson or rosy-red. The fructification consists of *spores*, *antheridia*, and *tetraspores*, all produced in similar situations, namely at the articulations, where they are surrounded by a kind of involucre formed of short ramelli, to which the tetraspores and antheridia are attached. The antheridia consist of a kind of shrubby tuft of extremely minute filaments arising from an axial filament which arises from a ramellus of the involucre. Fig. 287 represents a branch terminating in an involucre of whorled ramelli bearing tetraspores; the lower figure is a portion of a ramellus

Fig. 287.

Griffithsia sphærica.

Fig. 287. Fragment of a frond bearing an involucre with tetraspores. Magn. 50 diams.

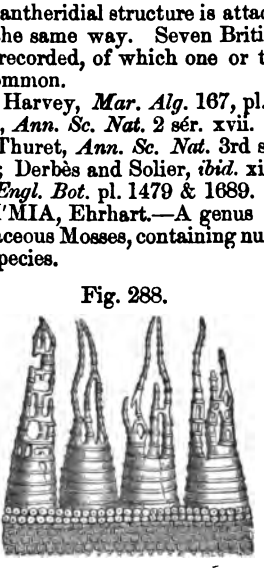
Detached ramellus of the involucre, showing the attachment of the tetraspores. Magn. 40 diams.

showing the mode of attachment of the tetraspores. In the antheridial involucres, the plumose antheridial structure is attached in exactly the same way. Seven British species are recorded, of which one or two are not uncommon.

Bibl. Harvey, *Mar. Alg.* 167, pl. 23 B; Decaisne, *Ann. Sc. Nat.* 2 sér. xvii. p. 353, pl. 16; Thuret, *Ann. Sc. Nat.* 3rd sér. xvi. 16, pl. 5; Derbès and Solier, *ibid.* xiv. 276, pl. 36; *Engl. Bot.* pl. 1479 & 1689.

GRIM'MIA, Ehrhart.—A genus of Orthotrichaceous Mosses, containing numerous British species.

Fig. 288.



Grimmia.

Teeth of peristome. Magnified 150 diameters.

Many of the species of *Trichostomum* of

Hedwig and Schwaegrichen are placed here by Bruch and Schimper and C. Müller.

Bibl. Wilson, *Bryol. Brit.* 152; Berkeley, *Handb.* 237.

GRO'MIA, Duj.—A genus of Rhizopoda, of the order Reticularia.

Char. Carapace brownish yellow, membranous, soft, globular or oval, with a small round orifice, from which very long, filiform branched expansions with very delicate extremities protrude; the presence of a nucleus and contractile vesicle is doubtful, or variable.

G. oviformis. Carapace globular, with a short neck; marine; size 1-25 to 1-12"; among marine plants.

G. fluviatilis (Pl. 31. fig. 15). Carapace globular or ovoid, without a neck; freshwater; breadth 1-280 to 1-100". Found upon *Ceratophyllum.*

Schlumberger describes a freshwater *Gromia (hyalina)*, differing from the last in size (1-860 to 1-520"), and in the carapace being colourless, perhaps the young state of *G. fluviatilis.* Schultze describes some new marine species: *G. oviformis, G. Dujardinii,* and *G. paludosa*; *G. terricola* (Leidy) is cream-coloured, and occurs in earth between paving-stones.

Bibl. Dujardin, *Ann. Sc. Nat.* 1835, iv., *Infus.* p. 252; Schlumberger, *Ann. Sc. Nat.* 1845, iii. 255; Schultze, *Polythal.* 55; Cienkowski, *Schultze's Arch.* 1876, xii. 32; Claparède and Lachm. *Inf.* 465; Leidy, *Sill. Am. Jn.* 1875 (*M. M. Jn.* xiii. 87).

GROWING-SLIDE.—Several modifications of this apparatus (*Introd.* p. xxiii) have been recently described.

See Smith, *Ann. N. H.* 1865, xvii. 334; Barker, *Qu. M. Jn.* 1866, 267; R. Beck, *Mic. Tr.* 1866, 34; Müller, *M. M. Jn.* i. 1869, 174; Maddox, *M. M. Jn.* 1870, iii. 14; Broeck, *M. M. Jn.* 1876, xv. 221; Lewis and Cunningham, *ibid.* 198; *Jn. Mic. Soc.* 1880, 333; Beale, *How &c.* 76; Botterill, *Jn. Mic. Soc.* xix. 34; Dallinger, *M. Mic. Jn.* 1874, xi. 97.

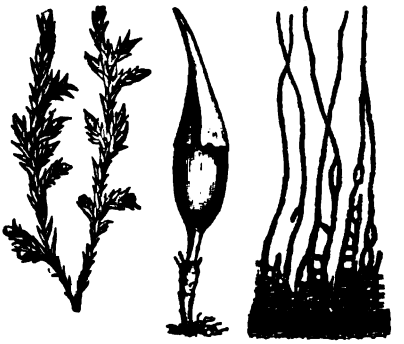
GUANO.—As is well known, guano is imported into this country in large quantities as a manure. It consists principally of the excrement of birds, in a more or less decomposed state. It affords the microscopist a means of procuring many foreign marine Diatomaceæ, the frustules and valves of which are often contained in it in large numbers. The Diatomaceæ may be obtained from guano as recommended at page 250.

GUEMBE'LIA, Hmp.—A genus of Orthotrichaceous Mosses, including various species separated from *Grimmia* on account of the peculiar calyptra, also the *Cinclidoti* of P. Beauvais.

G. orbicularis, Hmpe. = *Grimmia orbicularis,* Br. Eur.

G. riparia = *Cinclidotus riparius,* Wils.

Fig. 289. Fig. 290. Fig. 291.



Guembelia fontinaloides.

Fig. 289. A fertile shoot.
Fig. 290. Capsule with calyptra. Magn. 10 diams.
Fig. 291. Teeth from the peristome. Magn. 150 diams.

G. fontinaloides (figs. 289-91) = *Cincl. fontinaloides,* P. B.

Bibl. Wilson, *Bryol. Brit.* p. 139.

GUM.—A name applied to various viscid (not oily) secretions of plants. Gums have no microscopic structure when pure and clean, but often exhibit under the microscope traces of structures, such as débris of cellular tissue, filamentous Fungi, &c., which have become imbedded in them while soft. What is called gum Tragacanth consists of partly decomposed cell-membranes, in a condition allied to amyloid, retaining traces of their organization. Sections of very soft tissues or very minute objects may be made by imbuing them with or immersing them in solution of gum, and allowing the whole to dry up to a tough, semisolid mass, capable of being sliced with a razor. The slices are freed from gum by soaking in water. Gum dissolved in Glycerine forms an excellent medium for mounting vegetable tissues.

GUTTA-PERCHA.—A substance produced by the evaporation of the milky juice of the *Isonandra gutta,* of the Natural Order Sapotaceæ, a native of Sumatra and the neighbouring regions. Its relation to the microscope arises from its use in a

solid form and as cement, in mounting microscopic objects in cells. See CEMENTS and PREPARATION.

GUTTULINA. See POLYMORPHINA.

GY'GES, Bory.—Described by Ehrenberg as a genus of Volvocineæ, having neither eye-spot, tail, nor flagelliform filament; the carapace (cell-membrane) simple, subglobose; freshwater.

Motion very slow. He gives two species:

G. granulum (Pl. 50. fig. 14). Ovate or subglobose; internal granular mass dark green; diam. 1-1150".

G. bipartitus. Nearly spherical; internal mass yellowish green, frequently bipartite; diam. 1-480".

So far as appears from the descriptions and figures, these do not seem to differ from PROTOCOCCUS.

(For *G. sanguinea*, Shuttleworth, see RED SNOW.)

BIBL. Ehr. *Infus.* p. 51.

GYMNOAS'CUS, Bar.—A very minute and simple form of Ascomycetous Fungi; found on horse- and sheep's dung. (Baranetzki, *Bot. Zeit.* 1872; Sachs, *Bot.* 310; Eidam, *Cohn's Beit.* iii. 267; *Jn. Mic. Soc.* 1881, 489). See ASCOMYCES.

GYMNODIN'IUM, Stein.—A genus of Cilio-flagellate Infusoria=*Peridinia* without a lorica.

7 species; in fresh and salt-water (Kent, *Infus.* 442).

GYMNOGON'GRUS, Mart.—A genus of Cryptonemiaceæ (Florideous Algæ), with horny branched fronds, the divisions cylindrical or compressed, a few inches high, of a purplish-red colour. The substance of the branches presents three layers of closely packed filamentous cells, the central longitudinal, the intermediate curved, and the peripherical horizontal and moniliform. The spores have not been observed; the tetraspores (cruciate) are arranged in moniliform rows, in wart-like thickenings of the branches.

BIBL. Harvey, *Mar. Alg.* 145, pl. 18 B; *Engl. Bot.* pl. 1089 & 1926.

GYMNOGRAM'MA, Desv.—A genus of Grammitideæ (Polypodiaceous Ferns), some of the species of which are remarkable for a yellow or white pulverulent appearance on the back of the fronds, owing to the presence of abundance of microscopic cellular hairs, ex. gr. *G. Calomelanos*, *G. chrysophylla*, *ochracea*, &c. Many species, mostly tropical. (Hooker, *Syn. Fil.* 376.)

GYMNOMIT'RIUM, Corda.—A genus of Jungermannieæ (Hepaticæ), containing one British alpine species, the *Jungermannia concinnata* of the British Flora.

BIBL. Hook. *Brit. Jung.* pl. 3; Ekart, *Syn. Jung.* pl. 8. fig. 63; *Engl. Bot.* pl. 1022.

GYM'NOPHRYS, Cienk.—A genus of Reticularian Rhizopoda.

Char. Body naked, without nucleus or contractile vesicles. The pseudopodial reticulations, which exhibit the granular currents, arise from a few variable points of the surface.

G. cometa. In marine and boggy pools, among algæ. (Cienkowski, *Schultze's Arch.* 1876, xii. 31.)

GYMNOSPER'MIA.—A division of the Flowering Plants (see VEGETABLE KINGDOM), including the CONIFERÆ and CYCADACEÆ; deriving this name from the mode of development of the OVULES.

GYMNOSPORAN'GIUM, D.C.—A genus of Uredinei (Hypodermous Fungi). *G. juniperinum* grows upon living branches of the common Juniper, appearing at first like an exanthema on the bark, which in wet weather swells up into an orange-coloured, tremelloid plicate mass, which readily dries up, however, and then is scarcely visible. Somewhat rare, but when present generally copious.

BIBL. Berk. *Br. Fl.* vi. part 2. 361; Fries, *Syst. Myc.* iii. 505; Tulasne, *Ann. Sc. Nat.* 4 sér. ii. 171 & 188.

GYMNOSPO'RIUM, Corda.—A genus of Torulacei (Coniomycetous Fungi), characterized by an obscure mycelium and unicellular black spores arising apparently from the matrix. It is the lowest condition of which Torulacei are capable.

G. arundinis occurs in this country on reeds.

BIBL. Corda, *Anleitung*, 10; Berk. *Outl.* 328.

GYMNOS'TOMUM, Schwägr.—A genus of Mosses now distributed into PYRAMIDIUM, PHYSCOMITRIUM, and other genera.

BIBL. Müller, *Syn. Musc.*; Bruch and Schimper, *Bryol. Eur.*; Wilson, *Bryol. Br.* 39; Berkeley, *Handb.* 237.

GYPSI'NA, Carter. See TINOPORUS.

GYRI'NUS, Geoffr.—A genus of Coleopterous insects, of the family Gyrinidæ.

G. natator, one of the eight British species of this genus, is very commonly seen in groups performing its gyrations upon the

surface of pools or rivers, whence it has received the popular name of whirligig.

The body is ovate or elliptic, and depressed, the elytra black and shining. The antennæ are short and retractile within a cavity in front of the eyes; the basal joint minute; the second large, globular, and furnished externally with an ear-like joint fringed with colourless, flattened, hair-like processes; the remaining seven joints form a clavate mass, being very short and closely united, the first commencing by a very narrow base or pedicle. The eyes are divided by a transverse septum into two parts, the upper of which serves for viewing objects in the air, the latter those in water; by some authors these insects are described as possessing four distinct eyes. The terminal segment of the abdomen is furnished with two retractile ciliated lobes. The two fore legs are long, and of the ordinary form, whilst the four hind legs (Pl. 34. fig. 5), which are used as oars, are short, flat, and dilated; the femur (*d*) and tibia (*c*) somewhat triangular, the tibia also fringed with short spines and long flattened filaments; in the middle pair of legs the latter exist on both margins, whilst in the hind legs these are present only on the outer margin. The tarsi (*a*) are five-jointed, the three basal joints produced on the inside into long, flat, leaf-like lobes fringed with spines; the fourth joint is of about the same size, and semicircular, the fifth being very short and attached to the fourth near the end, and both are fringed on their outer margin with flattened filaments resembling those upon the tibia; all the tarsi are furnished with two distinct claws.

The anterior tarsi of the male differ from those of the female, as in *Dytiscus*. The circulating currents can be seen in the hind legs.

The larva (Pl. 35. fig. 19), which is aquatic, is of a dirty-white colour, long, narrow, and depressed, resembling a small centipede; it consists of thirteen segments including the head. Its antennæ are filiform and four-jointed; the eyes numerous and tubercular, grouped on each side of the head. The three pairs of legs are attached to the eight anterior segments of the body; the remaining segments are furnished on each side with a branchial filament, excepting the last, which has two of them, and four minute conical points, bent downwards, and used by the insect when in motion.

Bibl. Westwood, *Introd.* i. 105; Stephens, *Br. Coleop.* 78.

GYROC'ORIS, St.—A genus of Peritrichous Infusoria.

Char. Free, with one or more spiral or circular wreaths of cilia, stylate posteriorly.

G. oxyura. With anterior eye-spot; motion revolving, rapid. Stagnant water. (Kent, *Inf.* 640.)

GYRODAC'TYLUS, Nordm.—A genus of Trematode Entozoa.

G. auriculatus (Pl. 21. fig. 7) is often found adhering to the gills of fishes, as the carp, stickleback, &c.

Bibl. Dujardin, *Helminth.* 480; Wagener, *Qu. M. Jn.* 1861, 196; Cobbold, *Paras.* 465.

GYROPH'ORA, Ach.—A genus of Phylloidei (Lichenaceous Lichens), combined with *Umbilicaria* by many authors.

GYROPOREL'LA, Gümbel.—A small cylindrical Foraminifer, belonging to the *Dactyloporina*, and consisting of ring-like segments traversed by simple canals. Its several species constitute large masses of Triassic limestone in the Alps.

Bibl. Gümbel, *Abh. München*, xi. 268.

GYR'OPUS, Nitzsch.—A genus of mandibulate Anoplura (Insects), of the family Liotheidæ.

Char. Tarsi two-jointed, with a single claw.

Mandibles without teeth; maxillary palpi conical and four-jointed; labial palpi none; antennæ four-jointed; thorax two-jointed; abdomen eight-jointed.

G. ovalis (Pl. 35. fig. 8). Head ferruginous, transverse, with a lateral produced lobe on each side; thorax and legs ferruginous; abdomen nearly orbicular, yellowish white; claws long, curved, and strong; length 1-48″; found on the guineapig (*Cavia cobaya*).

G. gracilis. Head and thorax ferruginous; abdomen elongate, segments with a transverse striated band at each suture; claws very short and minute; length 1-36″; also on the guineapig.

3 other species: on the agouti, the sloth, and the peccary.

Bibl. Denny, *Anoplur. Monogr.*; Mégnin, *Paras.* 94.

GYROSIG'MA, Hass. See Pleurosigma.

H.

HÆMALAS'TOR, Koch.—A genus of Ixodea (Acarina); with the body of male entirely covered by a shield, yellow or red; no emargination in front; eyes clear and conical. Two species; on bats &c., Brazil and Hungary. (Murray, *Ec. Ent.* 198, figs.)

HÆMAPHY'SALIS, Koch.—A genus of Ixodea (Acarina); with the palpi very small, almost broader than long, three-cornered, the posterior margin of the second joint expanded outwards.

H. rosea. West Indies (Murray, *Ec. Ent.* 200, fig.).

HÆ'MATINE.—The red colouring-matter of the blood, in the globules of which it exists combined with globuline. It possesses no morphological characters.

BIBL. See CHEMISTRY.

HÆMATOCOC'CUS. See PROTOCOCCUS and GLŒOCAPSA.

HÆMATO'IDINE.—This substance, to which Virchow first drew attention, is not unfrequently met with in masses of extravasated blood which have remained for some time in the living bodies of the Vertebrata, as in old apoplectic clots, sanguineous extravasations resulting from contusions and wounds, the effusions accompanying the rupture of the Graafian vesicles, &c.

It occurs in the form of granules, globules, and distinct crystals. These are somewhat highly refractive, and mostly of a ruby-red or yellowish-red colour; they are stated also to have been found colourless. The most common forms are represented in Pl. 13. fig. 16, and they appear to belong to two distinct systems—the oblique rhombic prismatic, and the regular system.

The properties of hæmatoidine are as inconstant as the crystalline form; and it is probable that several different substances have been ranged under the above title, or perhaps modifications of the same substance in different states of hydration; for so insuperable has been the difficulty of obtaining hæmatoidine in quantity and a state of purity, that its true nature has not been satisfactorily determined. By some it is considered as bilirubine, or a modification of it.

It is mostly insoluble or difficultly soluble in water, alcohol, ether, acetic and dilute mineral acids, and solution of potash. Sometimes it is soluble in acetic acid, with a yellow colour, at others readily so in water. It contains no iron.

An amorphous colourless proteine substance is sometimes separated from the crystals by the action of mineral acids.

Hæmatoidine may be artificially procured from various sources, perhaps most readily from the blood of fishes by spontaneous evaporation. The blood of the spleen of the horse changes almost entirely into prismatic crystals of it in drying. In obtaining the crystals the presence of the serum is prejudicial, and it should be washed away with a small quantity of water. If recently dried blood be treated with a vegetable acid (acetic, oxalic acid, &c.), and a drop of the solution be placed upon a slide, covered with thin glass, and kept at a temperature of 80° to 100° F., the crystals may also be obtained. This reaction might be of use in judicial investigations. The addition of water and a little alcohol or ether to the blood, sometimes favours the separation of the crystals.

Crystals of hæmatoidine (?) have been found within the blood-globules prior to the addition of reagents.

Their preservation is difficult; it is best effected by washing them with alcohol, or this liquid somewhat diluted with water, and drying them under the air-pump, or over sulphuric acid.

BIBL. Virchow, *Ann. Chem. u. Pharm.* 1851 (*Chem. Gaz.* 1852); Funke, *Zeitsch. f. rat. Med.* 1851, i. 172, 1852, ii. 199 & 288; Kunde, *ibid.* 1852, ii. 271; Lehmann, *Gmelin's Handb.* viii.; Sanderson, *Edinb. Mn. Jn.* xiii. 216, 521; Kölliker, *Mik. An.*; Teichmann, *Zeits. f. rat. Med.* 1853, iii. 375; Frey, *Histol.* 1876; Preyer, *Blut-Krystalle*; Hoppe-Seyler, *Anal. Chim.* 1877, 242.

HÆMATOPI'NUS, Leach.—A genus of Insects, of the order Anoplura, and family Pediculidæ.

Char. Legs all formed for climbing; thorax generally narrower than the abdomen, and distinctly separated from it; abdomen composed of eight or nine segments.

This genus contains several species (28 Mégn.), which live as parasites upon various animals—the field-mouse, rat, dog, ox, horse, ass, calf, hog, rabbit, hare, squirrel, &c.

H. suis (Pl. 35. fig. 4; fig. 4*, anterior leg). Dusky ferruginous; abdomen grey or ashy-yellow, flat and membranaceous, with a black horny excrescence surrounding each of the white spiracles; legs long and thick; femur transversely striped; tibiæ very ab-

ruptly clavate, dark-coloured at the end; tarsi with a large fleshy pulvillus.

Found upon pigs out of condition; length 1-10 to 1-6″.

Bibl. Denny, *Anopl. Brit.* 24; Gervais, *Walckenaer's Aptères*, iii. 301; Mégnin, *Paras.* 76.

HÆMATOPO'TA, Meig.—A genus of Dipterous Insects, of the family Tabanidæ.

Distinguished by the six-jointed antennæ, which are longer than the head, with the third joint thickened at the base.

H. pluvialis, of which most persons must have experienced the pungent bite in or near woods in warm weather, is interesting on account of the great development of the lancets, and the beautiful iridescence of the eyes.

HÆMATOZO'A. See Blood, p. 105, & Filaria, p. 324.

HÆ'MINE.—This consists of hydrochlorate of hæmatine.

HÆMO'CHARIS, Sav. (*Piscicola*, Blainv.).—A genus of Annulata.

H. piscium (*Piscicola geometra*) is a leech-like animal, found upon the carp, tench, roach, &c. Length 1 to 2″.

Bibl. Leo, *Müller's Arch.* 1835; Leydig, *Siebold und Kölliker's Zeitschr.* i.; Brightwell, *Ann. N. H.* 1842, ix. 11.

HÆMOGLO'BINE. See Blood, p. 102.

HÆ'MOPIS, Sav.—A genus of Annulata.

H. sanguisorba, the common horse-leech. In this animal the teeth are less numerous and more obtuse than in the medicinal leech (*Hirudo officinalis*).

HAIL.—The microscopic structure of hail-stones does not appear to be uniform. In some a central nucleus surrounded by concentric layers has been noticed; in others the nucleus is enveloped by a radiating crystalline crust; or, again, the entire mass has been found to consist of little spheres of ice. When hail-stones liquefy, a copious evolution of gas takes place. Hail-stones may best be collected for examination in a blanket, which being a bad conductor of heat, retains them longest in the solid state. Connected with the structure and formation of hail-stones, is the composition of spherules of condensed vapour. These are generally believed to consist of films of water enclosing portions of air; but Waller's observations have led him to the conclusion that they are simply composed of water. If the former view were correct, those hail-stones which consist of aggregations of icy spherules, should contain air within them, which does not appear to be the case; but in deciding this question, attention must be paid to the principles laid down in the Introduction, p. xxxvi, *f.*, which afford a simple means of deciding the point.

In some liquefied hail-stones, the spores of fungi and algæ, with infusoria, have been found.

Bibl. Pouillet, *Elém. d. Physique*, ii.; Waller, *Phil. Tr.* 1847, 23; id. *Phil. Mag.* 1846, xxix. 103, and 1847, xxx. 159; Harting, *Skiz. aus d. Natur.*

HAIR of Animals.—The structure of the hair of animals is very complicated, and requires careful manipulation for its investigation. We shall commence with the hair of man, in which it has been the most perfectly examined.

Human hair. When a hair is viewed under a low power, it appears black at the sides and light in the middle, so as to convey a notion of its being a tube; such is not, however, the case, although this notion was long admitted.

The hairs are secreted by the skin, and consist of modified epidermic formations. Each is implanted in a cutaneous depression, termed the hair-follicle (fig. 292), at the bottom of which it is fixed by a dilatation called the knob or bulb of the hair (*c*). The free portion, or that projecting beyond the skin, is the shaft or scape (*a*); and that above the bulb but contained within the follicle, is the root (*b*). The bulb encloses or surrounds a conical or rounded body (*i*), the papilla or pulp.

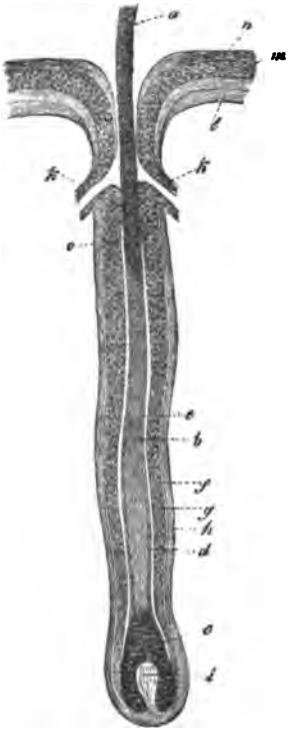
Three varieties of hair are met with upon different parts of the body: 1, consisting of long, soft hairs, from 1 to 3″ and more in length, as the hair of the head; 2, short, rigid and thicker hairs, from 1-4 to 1-2″ in length, as in the eye-lashes; and 3, short, very slender hairs, from 1-12 to 1-6″ in length, as in the down or woolly hairs of the face, the back and extremities.

When the shaft of a hair is examined under the microscope by transmitted light, two structures are mostly distinguishable, a median, more or less black, somewhat irregularly granular and linear portion—the medulla or pith; and an outer, fibrous-looking portion, mostly more or less coloured according to the colour of the hair—the cortex, cortical or fibrous portion.

The *cortical portion* is that upon which the firmness, elasticity, and colour of the

hair depends, and constitutes the greater portion of its bulk. It exhibits numerous longitudinal striæ, or interrupted dark lines and dots. When acted upon by strong sul-

Fig. 292.

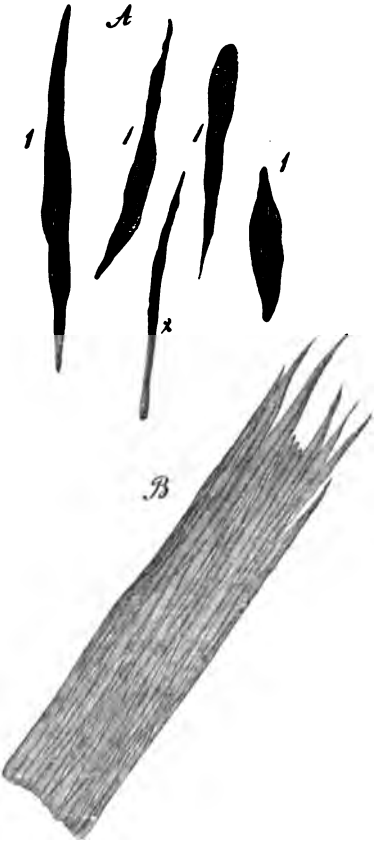


Magnified 50 diameters.

A hair of moderate size, contained in its follicle. *a*, shaft; *b*, root; *c*, bulb or knob; *d*, cuticle of the hair; *e*, inner sheath of the root; *f*, outer sheath of the root; *g*, structureless membrane of the hair-follicle; *h*, transverse- and longitudinal-fibrous layer of the same; *i*, papilla; *k*, excretory ducts of the sebaceous glands or follicles, with their epithelial and fibrous layer; *l*, cutis of the orifice of the hair-follicle; *m*, rete mucosum; *n*, cutaneous epidermis; *o*, termination of the inner sheath of the root.

phuric or some other acid at a gentle heat, it becomes at first resolved into plates or fibres (fig. 293 *B*) of the most varied sizes, both as to length and breadth; but if the action of the acid be continued, these fibres become separated into cells (fig. 293 *A*). These cells present uneven surfaces, and a more or less eliptical outline, their true form being spindle-shaped; but they are mostly flattened and angular, or curved from mutual pressure, resulting from their aggregation into the shaft of the hair. The cells are about 1-500 to 1-300″ in length, and

Fig. 293.



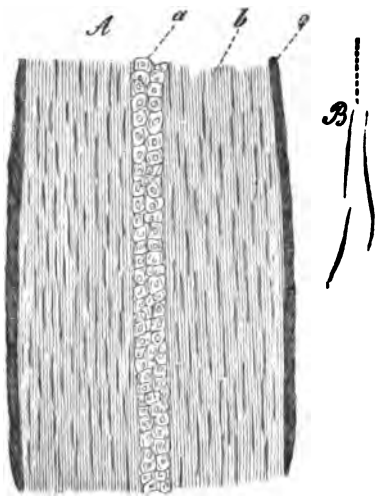
Magnified 350 diameters.

Plates and cells of the cortical substance of a hair, after treatment with acetic acid. *A*, separate cells. 1, front view (three of them isolated, two united); 2, side view. *B*, a layer, composed of several cells.

from 1-6000 to 1-2200″ in breadth. They mostly contain elongated, dark-looking nuclei, 1-1100 to 1-400″ in length; these are well seen in a colourless hair, heated with soda or potash (fig. 294 *A b*, and *B*); in coloured hair they also contain pigment-granules, to which the colour of the hair is

principally owing. The pigment-granules are exceedingly minute, about 1-50,000″ in diameter, rounded, and, as existing in the hair, are mostly arranged in linear groups,

Fig. 294.



Magnified 350 diameters.

A, Portion of a white hair after treatment with soda. *a*, nucleated cells of medulla, free from air; *b*, cortical substance with fibrillation and linear nuclei; *c*, cuticle. *B*, three isolated nuclei from the cortex.

their colour and number varying with that of the hair. The pigment-granules are best separated by the action of caustic potash or soda, and they frequently exhibit molecular motion.

The striated and dotted appearance of the shaft of hairs is not produced simply by the nuclei, nor by the pigment, but arises in part also from the unequal refraction of the light by the various parts of the cells, and from the presence of minute spaces filled with air. The nature of each can always be determined by attention to the principles laid down in the INTRODUCTION.

Towards the bulb, the cells of the cortex are more distinct, less elongated, and, as well as the nuclei, more easily isolated when treated with acids (fig. 295), whilst in the bulb itself they are round (fig. 296), 1-4000 to 1-1800″ in diameter, closely crowded, and sometimes containing only a colourless nucleus, at others pigment-granules.

The *medulla*, like the cortex, consists of a number of cells. Its structure is best observed in a hair which has been treated with soda or potash. The cells are then seen to

Fig. 295. Fig. 96.

Magnified 350 diameters.

Fig. 295. Two striated cells from the cortex of the root close above the bulb, with nuclei.
Fig. 296. Cells from the deepest portions of the bulb; *a*, from a coloured bulb, with pigment-granules and partly concealed nuclei; *b*, from a white hair, with distinct nuclei and a few granules.

be arranged in one or more linear series (fig. 294 *a*); they are angular or rounded, 1-2000 to 1-1000″ in diameter; and if the action of the alkali has not been too long continued, they exhibit a nucleus; they frequently also contain one or more granules or globules of fat (fig. 297). In the shaft and

Fig. 297.

Magnified 360 diameters.

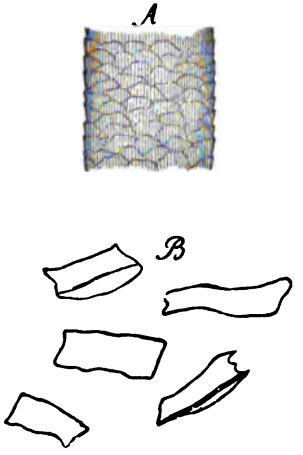
Medullary cells with pale nuclei and fatty granules, from a hair treated with soda.

upper part of the root of the hair, these cells contain air, which gives them a dark or black appearance by transmitted light; and it was the generally received opinion, until we pointed out the error several years ago, that this darkness or blackness arose from the presence of pigment. The contrary, however, may be easily proved by macerating the hair in oil of turpentine or any liquid, when the air escapes in bubbles and becomes displaced by the liquid; moreover, on drying the hair, the air and black appearance return. Pl. 29. fig. 1 represents a white hair, in which the medullary cells of

the lower part are filled with Canada balsam, whilst those of the upper portion still contain air. Again, examination by reflected light is equally conclusive; for under it the black medullary portions become white, which would not be the case did the blackness arise from pigment. Pl. 29. fig. 9 illustrates this in the hair of the Lion; where *a* represents the hair as seen by transmitted, and *b* by reflected light.

Cuticular coat. The shaft and root of the hair, above the termination of the inner root-sheath, are coated externally by a firmly adherent, thin, simple, membranous layer, consisting of flat, imbricated, epithelial scales. In the natural state of the hair, the existence of these scales is only indicated by the presence of irregularly transverse and anastomosing lines seen upon the surface, or slight dentition of the margin (fig. 298 *A*). But when the hair has been

Fig. 298.

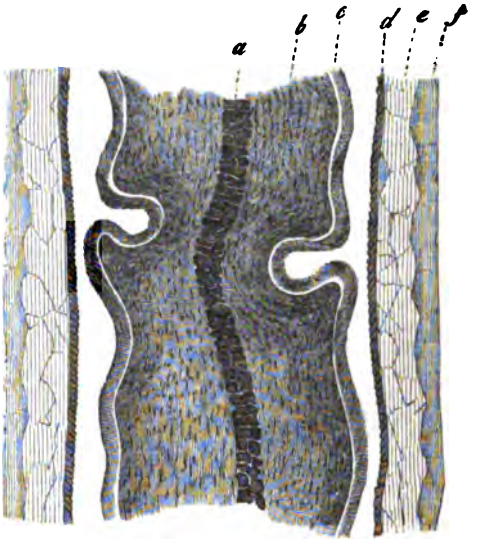


Magnified 160 diameters.

A, surface of the shaft of a white hair, the curved lines indicating the free margins of the epidermic scales. *B*, scales isolated by the action of soda.

treated with an acid or an alkali, the scales become separated. Their free margins are directed towards the unattached end of the hair. The scales are much more distinct without treatment, in the hair of the newly-born infant (Pl. 29. fig. 3). They are very transparent, somewhat quadrangular, flattened or curved cells (fig. 298 *B*), not containing a nucleus; their margins or edges

Fig. 299.



Magnified 250 diameters.

Portion of the root of a dark hair, slightly acted upon by soda: *a*, medulla, the cells still containing air; *b*, cortex with pigment; *c*, inner cuticular layer; *d*, outer cuticular layer; *e*, inner layer of the inner root-sheath; *f*, outer perforated layer of the same.

are often black, and, as the other parts are transparent, they are apt to be overlooked. They are about 1-700 to 1-500″ in length, and one half or one third of this in diameter.

In the lower part of the root, below the termination of the root-sheath, the cuticular coat is double, or consists of two layers. The above-mentioned cuticle of the shaft and upper part of the root forms the continuation of the innermost of these, which possesses nearly the same structure, except that the scales of which it consists are somewhat longer, and directed more obliquely outwards. These layers are best seen in a hair treated with an alkali, especially with the aid of pressure; they then become separated (fig. 299), the inner, with the roo of the hair, assuming an undulating form, and remaining firmly adherent (*c*), whilst the outer (*d*) remains attached to the inner root-sheath, its cells also being broad and without nuclei. At the bulb, both these layers become transformed into soft cells broader than long, with transverse nuclei, finally becoming fused with the round cells of the bulb.

The *hair-follicles* are pouches, about 1-10 to 1-4″ in length, pretty closely surrounding the hairs, and extending in the short hairs into the substance of the upper layer of the cutis; but in the long hairs, into its deepest portion, or even into the subcutaneous cellular tissue. They may be regarded as prolongations of the skin, with its components, the cutis, basement-membrane, and epidermis. Hence three parts are distinguishable in them: an external, fibrous, very vascular portion—the proper hair-follicle; a basement-membrane; and a non-vascular cellular coat—the epidermis of the follicle, or, because it surrounds the root of the hair, the root-sheath.

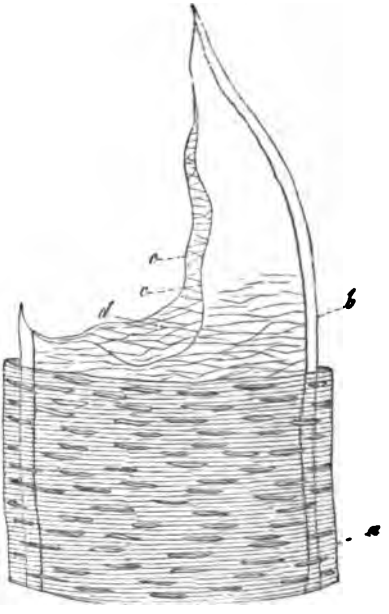
The fibrous portion of the follicle consists of two layers or membranes. The outer one (fig. 292 *h*) is the thicker, and contains vessels and nerves. Its inner surface is connected with the inner layer; externally it is attached to the surrounding areolar tissue; and above, it is continuous with the outer layer of the cutis. It consists of common areolar tissue, the fibres of which are longitudinal, with elongated spindle-shaped nuclei. The inner layer (fig. 300 *a*) is much more delicate, and only extends from the base of the hair-follicle to the orifice of the sebaceous follicles. It consists of a single layer of transverse fibres, with long and narrow nuclei, resembling unstriated muscular fibres.

The third layer (fig. 300 *b*), or basement-membrane, is transparent and structureless, and extends from the base of the follicle, without apparently covering the papilla, as far as the inner root-sheath, and perhaps higher. It presents delicate transverse anastomosing lines, producing a fibrous appearance.

The *pulp* or papilla of the hair (fig. 292 *i*) belongs to the follicle, and corresponds to a papilla of the skin. It is rounded or oval, 1-96 to 1-480″ in length, is connected with the fibrous coat of the follicle by a kind of stalk, and consists of indistinctly fibrous areolar tissue with nuclei and granules of fat, but contains no cells.

The two *root-sheaths* consist of the epidermic covering of the hair-follicle. The *outer* (fig. 292 *f*) is the continuation of the rete mucosum of the skin, and lines the entire follicle. Its lower part is in contact externally with the basement-membrane of the follicle; but above the termination of the inner transverse layer of the follicle, it is in direct contact with the outer or longitudinal layer. It consists of several layers of nucleated cells, resembling those of the rete mucosum of the skin, the outer having their long axis perpendicular to that of the hair, the others, especially towards the bulb, being rounded. This outer root-sheath is most distinct in the follicles of the skin of the negro, from which it may be withdrawn with the epidermis after maceration.

Fig. 300.



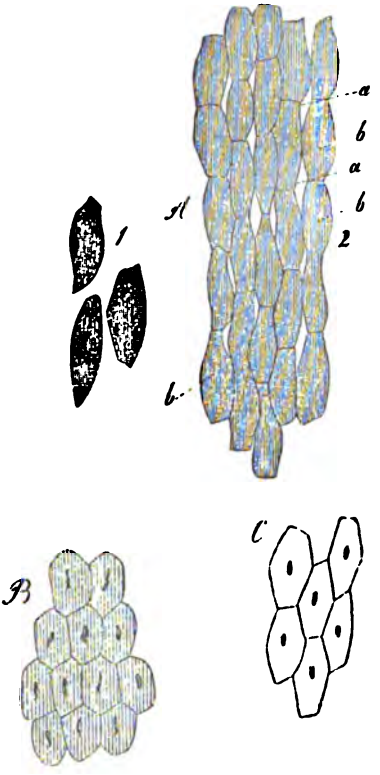
Magnified 300 diameters.

Portion of the inner fibrous coat and basement-membrane of a hair-follicle: *a*, inner coat with transverse fibres and elongated transverse nuclei; *b*, basement-membrane, seen as it were in section; *c*, its lacerated margins; *d*, fine lines (fibres?) on its inner surface.

The *inner root-sheath* (fig. 299, *e*, *f*) forms a transparent, very firm and elastic, yellowish membrane, extending from near the base of the hair-follicle to near the mouths of the sebaceous follicles, where it terminates abruptly with a jagged margin. Externally it is connected with the outer root-sheath, internally with the outer layer of the cuticle of the hair; hence no interval exists naturally between it and the hair. At first sight it appears as a perfectly homogeneous membrane, but on closer examination it is seen to be distinctly cellular; it consists of two

or three layers of polygonal, longish, transparent cells, with their long axis parallel to that of the hair. The *outermost* (Henle's) layer (figs. 299 *f*, 301 *A*) consists of long,

Fig. 301.



Magnified 350 diameters.

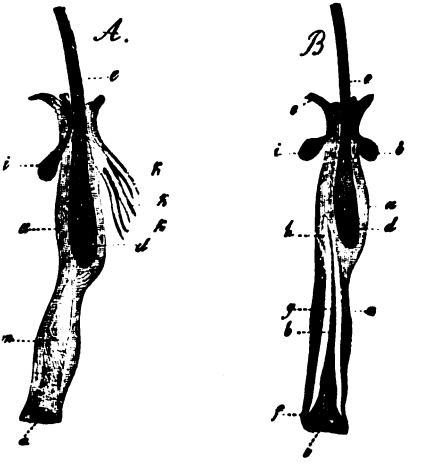
Elements of the inner root-sheath. *A*, external layer: 1, isolated plates; 2, the same in connexion, showing the interspaces (*a*) between the cells (*b*). *B*, cells of the inner non-perforated layer. *C*, nucleated cells of the lower part of the inner sheath, which consists of a single layer only.

flattened, non-nucleated cells, from 1-700 to 1-500″ in length, with fissures between them, forming a fenestrated layer. The *innermost* (Huxley's) layer (figs. 299 *e*, 301 *B*) consists of one or two layers of shorter and broader polygonal cells, from 1-1200 to 1-600″ in length; their nuclei, which exist in the lower part only of the coat, are often broader at the ends than in the middle, sometimes curved and pointed. At the base of the hair-follicle, the inner root-sheath consists of a single layer only of beautiful, polygonal, nucleated cells (fig. 301 *C*); these becoming soft, delicate and rounded, gradually pass into the outer layers of the round cells of the bulb.

In regard to *development*, the rudiments of the hair appear as processes of the rete mucosum descending in the substance of the cutis. These are solid, and consist of cells, the internal of which become horny, and form first a small slender hair in the axis of the process, next an inner sheath surrounding the former, whilst the outer cells remain soft, and form the outer sheath and the cells of the bulb.

After birth the fœtal hair appears to be completely shed, new hairs being formed in the old follicles, which displace the first set, as shown in figs. 302, 303.

Fig. 302. Fig. 303.



Magnified 20 diameters.

Eye-lashes of a child a year old. *A* exhibits a process (*m*) of the bulb or outer root-sheath, in which the central cells are elongated, and form a cone distinct from the outer cells. *B*, one more advanced, in which the inner cone has become developed into a hair and an inner root-sheath: *a*, outer, *b*, inner root-sheath of the young hair; *c*, pit for the pulp; *d*, bulb; *e*, shaft of the old hair; *f*, bulb, *g*, shaft, *h*, summit of the young hair; *i*, sebaceous follicles; *k*, three sudoriparous ducts opening into the upper part of the hair-follicle.

The hairs sometimes found developed upon mucous membranes, and within encysted tumours and ovarian cysts, possess the normal structure in every respect.

Of the morbid states of the human hair, we need mention only the loss and change

of colour, and the presence of fungi. When the colour entirely vanishes, and the hair becomes white or grey, the cells of the medulla contain abundance of air. This arises from degeneration or impaired nutrition; the liquid contents of the cells are not supplied in sufficient quantity; they therefore evaporate, and the cells being prevented from collapsing by their adhesion to each other and to the firm cortex, become filled with air, which replaces what would otherwise constitute a vacuum. Fungi are found in FAVUS upon the cortex of the hair, within the follicles, and even within the hair itself, as is stated. In Porrigo decalvans also, fungi are stated to occur in the hairs.

The principal differences between the hair of man and of animals, and that of animals from each other, relate to—1, the size; 2, the relative proportions of the cortical and medullary structures; 3, the locality of the pigment; 4, the arrangement of the medullary cells; 5, the comparative amount of true hair, and woolly hair, down, or wool; and 6, the size and projection of the superficial cortical cells or scales.

Of these we shall give a brief sketch (Pl. 1. figs. 1–3, and Pl. 29).

The hair of the Mammalia generally is formed upon the same plan as that of man; great variety, however, exists in its complexity of structure and the arrangement of the component parts.

Quadrumana (Pl. 29. figs. 4 & 5). In the monkey (Indian) (fig. 4), the hair presents much of the same structure as in man; the pigment is confined to the cortex, but the air-cells of the medulla are larger and less crowded; this is seen to a greater extent in the hair of the lemur (fig. 5).

Cheiroptera. In the bats (Pl. 1. fig. 2; Pl. 29. figs. 6 & 7), a striking character is the peculiar development of the cortical scales of the surface. In the hair of the common bat (Pl. 1. fig. 2), which is one of the TEST-OBJECTS, and Australian bat (Pl. 29. fig. 7), this character is not so striking as in that of the Indian bat (fig. 6), in which the scales are grouped in whorls at pretty regular intervals along the shaft, and project considerably beyond the surface. The pigment is principally confined to these whorled scales. In some of the white hairs of the bat, the individual scales are very beautifully seen (Pl. 1. fig. 2 *c*).

Insectivora. The hair of the mole (Pl. 29, fig. 8) bears some resemblance to that of the bats: but the cells of the medulla are very distinct. (See SPINES.)

Carnivora (figs. 9–13). In this Order the structure of the hair varies considerably. In the lion (fig. 9) the cortical cells are distinct, but not projecting; the medullary cells are very numerous, and the air-spaces minute, but closely aggregated, as we often find them in the human hair. In the bear (fig. 10), the large hairs present much the same structure as in the lion; the wool-hairs differ strikingly from these, however, in the distinctness of the cortical and medullary cells.

Pachydermata (figs. 14–17). In this Order the hairs present a development corresponding with that of the skin; being very thick and complex in structure. In the elephant (fig. 15, transverse section), each hair resembles a number of hairs fused together. Scattered through its substance are pale spots formed by cells containing little or no pigment, with an irregular perforation in each, probably arising from rupture of the cells. Surrounding these medullary centres are innumerable cortical cells loaded with pigment. In the pig (fig. 16), the distinction between the cortex and medulla is not well marked, and the cells assume a radial direction, as indicated by those which contain most pigment. In the Cheiropotamus (fig. 17) the distinction is more evident.

Ruminantia (figs. 18–22). In this Order the hair presents great variety. In the camel (fig. 18) and dromedary (fig. 19), the true hair exhibits much the same structure as that of the higher Orders, whilst in the deer (fig. 20, moose-deer; fig. 21, musk-deer) the medullary portion is enormously developed at the expense of the cortical portion; in no hair is the cellular structure more distinct than in the two latter, the medulla closely resembling a piece of vegetable cellular tissue. The wool-hair in this class presents the characteristic structure. That of the camel (fig. 18 *b*) agrees in structure with the type of wool from the sheep (fig. 22) in its softness, flexibility and waviness, and in the distinctness of the cortical cells.

Edentata (figs. 23 & 24). The difference between the hair of the three-toed sloth (fig. 23) and that of the armadillo (fig. 24) is well-marked. In the former, the cortical cells take a remarkably oblique or radiating course, whilst in the latter they run longitudinally.

Rodentia (figs. 25–35). In this Order the

pigment is met with sometimes in the medulla, at others in the cortex. The arrangement of the air-cells is often very beautiful, and has rendered these hairs favourite microscopic objects. Portions of a mouse-hair in various parts of its length are represented in fig. 27, *a* forming the free end. Fig. 28 displays two portions of the same hair as histolyzed by treatment with solution of potash. The cortical parts have not been resolved into their component cells, whilst those of the medulla have assumed their rounded and natural form, and exhibit minute granules of pigment, with larger globules of fat. The arrangement of the medullary cells in two rows is seen in fig. 28 *b*. The pigment within the cells *in situ* is seen in fig. 31 *b*, from the rabbit. The wool presents its characters in a marked degree, the projection of the outer layer of cortical cells and the distinctness of the medullary air-cells being very evident.

Marsupialia (figs. 36 & 37). In this curious Order the hair greatly resembles that of the Rodents. That of the kangaroo presents very beautifully imbricated cortical cells (fig. 36).

Monotremata. The structure of the hair of the Ornithorhynchus is as peculiar as that of the animal in general. It presents that of hair and wool combined (fig. 38). The basal portion resembles wool, and is very long and narrow; the structure of two pieces in different parts of its length is seen in fig. 38 *c* and *d*. At the end of this portion is attached the proper hair containing the pigment within the cortical substance (*b*); fig. 38* represents the surface-view of the hair, showing the imbricated scales.

In Birds the hair is replaced by FEATHERS.

The hair of the Invertebrata does not present the same structure as that of the higher animals; some physiologists have therefore limited the term hair to the filiform epidermic formations of the Mammalia, whilst others admit the occurrence of hair in all classes of the animal kingdom. At all events, the hairs of the Invertebrata are not usually composed wholly of epidermis. They consist of an outer cortical or epidermic layer, frequently coloured, and upon which their firmness depends; lining this is sometimes a prolongation of the cutis, at others a colourless substance which, when the hair is dried, presents an irregular cell-like appearance and contains air, so as to resemble the air-cells of the hair of the Mammalia. In other instances the hair is completely solid, but exhibits no trace whatever of cell-structure. It remains to be shown whether the latter may represent the epidermis hardened in an amorphous state, and whether those lined with cutis may be regarded as epidermic formations upon an exserted papilla of the skin; whilst those presenting the air-cells when dried correspond to an outer hardened epidermic layer, and an inner retaining its distinctly cellular state. In those lined with cutis, the circulation can sometimes be observed.

We have space to notice only a few instances of variety of form, many of which occur, and have long rendered these hairs interesting and elegant microscopic objects. Thus, in some of the Arachnida they are feathery, giving off slender lateral branches, as in *Lycosa* (Pl. 29. fig. 40), *Epeira* (Pl. 6. fig. 8 *b*), *Acarus* (Pl. 6. fig. 1 *b*), &c.; in others these branches are directed forwards near the middle of the shaft, but recurved at the end, as in *Mygale* (the bird-catching spider) (Pl. 29. fig. 41); or, while the branches on the shaft resemble the above, the end of the hair is thickened, cylindrical and longitudinally striated, with minute setæ arising from the striæ, as in fig. 42; again, some of them are simple, but furnished with spiral striæ (*Epeira*, Pl. 6. fig. 8 *a*); in *Trombidium* they are sometimes very elegantly feathery.

In Insects, Arachnida, &c., they often appear to rise from a bulb at the base; but the bulb is not solid, and bears no resemblance in structure to the bulb in the Mammalia; it consists of a thickening or fold of the epidermis of the skin, not of the hair, from which it is separated by a white ring, indicating thinness of this coat, and often corresponding to a joint; the hair arises from the base of a depression situated within the annular bulb. The hair of some of the larvæ of the Dermestidæ is very beautiful, and is used as a TEST-OBJECT. Two forms are met with: in one (Pl. 1. fig. 1 *c*) the shaft is simply covered with densely aggregated, minute, spinous secondary hairs; in the other (Pl. 1. fig. 1 *a*, *b*), the spines or scales upon the shaft are narrow, acute, and placed in pretty regular whorls; in the uppermost whorl they are broader, the spines remaining as midribs, whilst the margins are more developed, the whole resembling a flower with four or five petals; but at the end of the hair, the scales are longer, narrower, and recurved,

each midrib being terminated below by a little knob.

The examination of the hair and its dissection can only be effected by the aid of chemical reagents, especially sulphuric acid, solution of potash or of soda. These should first be used cold; and if no separation of the components ensues, heat even to boiling must be applied; the subsequent addition of water is sometimes advantageous. Sections of hair can be made with a razor, a bundle of hair being fixed between two flat pieces of cork, or between two cards. Transverse sections of the human hair can be obtained by shaving a second time, an hour or two after the first; the sections should then be washed in water. The cortical cells are most beautifully seen in white hairs which have been thoroughly soaked in oil of turpentine, and mounted in Canada balsam. The air-cells of the medulla are best observed in hairs which have been mounted in balsam without the previous application of turpentine. The sheaths of the hair keep best in solution of chloride of calcium or glycerine.

Many of the structures of the hair of the Mammalia may be well observed in the large hairs or bristles (whiskers) of the ox, &c.; in these also the pulp is seen to contain blood-vessels, which have not been detected with certainty in that of man. They also exhibit bands of smooth muscular fibres, arising from the cutis, descending through the hair-follicles, and terminating below the sebaceous follicles, forming the erectores pili.

The hairs of some animals polarize light. An interesting object of this kind may be made by placing two series of the white hair of a horse in balsam, so as to cross each other at an angle, and viewing them by polarized light (Pl. 39. fig. 39).

In regard to the discrimination of the hairs of one animal from those of another, we believe that the examination of individual hairs can in general be but little depended upon; whilst a comparison of their form, length, and breadth, with the proportion of the true hair to that of the wool, conjoined with the consideration of the internal structure, may often enable an observer to arrive at a satisfactory conclusion.

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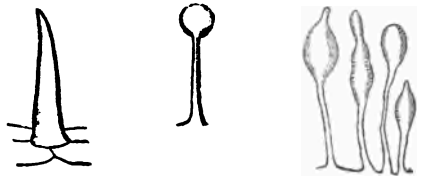
HAIRS OF PLANTS, *trichomata* or *trichomes*.—The term hair is applied in botany to filamentous productions upon the surface of the organs of plants, consisting of one or more cells arising out of and constituting part of the epidermal structure. Hairs of plants present a great variety of conditions: in the simplest kind—those composed of a *simple*, cylindrical, conical, bifurcated or stellate cell—they may be varied in *form* by the peculiar shape of the constituent cell, in *individual character* by the presence or absence of special secretions in the cell-cavities, and in their *collective character* by the mode of arrangement on the epidermis, since they may be few and scattered, or so numerous as to form a velvety coat. *Compound* hairs, namely those composed of a number of cells, vary in like manner, and, moreover, in the examples where the cell-walls acquire considerable thickness, pass gradually from pure *hairs* into *bristles*, and thence into the structures called THORNS (distinguished from true spines by being appendages of the epidermis). The stellate forms also present many variations intermediate between hairs proper and SCALES.

These structures are interesting to the microscopist on account of the variety and often extreme elegance or curiosity of their forms. They likewise strongly attract the attention of the physiologist from the simplicity of their organization and their free condition, allowing the phenomena presented by the cell-contents to be readily observed under the microscope. In reference to their characters as microscopic objects, it will suffice to indicate their principal modifications, and state a certain number of examples. For this purpose they may be classified as follows:—

Simple hairs: unbranched, Cabbage-leaf (*Brassica*, fig. 304), *Œnothera*, *Dictamnus* (Pl. 28. fig. 39 *a*), *Anchusa* (fig. 17); *bifurcated*, *Capsella* (fig. 36), *Draba* (fig. 307); *inflated* or *capitate*, *Antirrhinum* (fig. 306 and Pl. 28. fig. 34), *Salvia* (fig. 305), *Helleborus fœtidus*; *branched*, in many Cruciferæ,

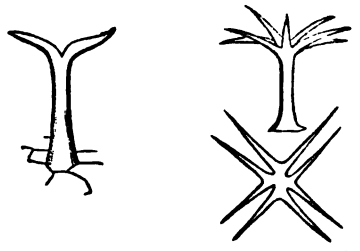
as *Sisymbrium Sophia* (fig. 35), *Alternanthera axillaris* (fig. 37); *stellate, Alyssum* (fig. 308). Very often hairs composed of a single cell are supported upon a short stalk, and then developed horizontally in two directions, as in *Grevillia lithidophylla* (fig. 29); in several so as to form a star, as in *Deutzia scabra* (fig. 26*), *Alyssum* (fig. 28). Structures analogous to the last occur upon the septa of the air-cavities of the Nymphæaceæ, such as *Nuphar lutea* (fig. 15), *Victoria*, &c.

Fig. 304. Fig. 305. Fig. 306.



Hairs of:—
Brassica (leaf). Salvia (calyx). Antirrhinum (corolla).

Fig. 307. Fig. 308.

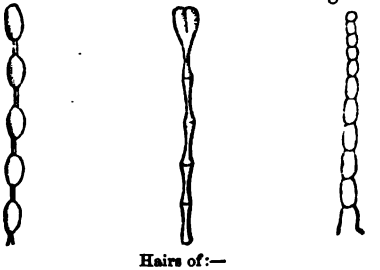


Draba (leaf). Alyssum (leaf).
Magnified 100 diameters.

Compound Hairs. These exhibit a similar diversity of character, and often imitate, on a larger scale, the forms of the simple hairs; they may be *unbranched*, as in the hairs of the garden *Pelargonia* (Pl. 28. fig. 18), and a large proportion of ordinary silky hairs upon the epidermis of plants. Cotton is a striking example, consisting of the hairs of the seeds of *Gossypium* (fig. 1).

Commonly these hairs are cylindrical; but not unfrequently one or more of the uppermost or all the component cells are expanded into a more or less globular form. *Capitate* glandular hairs often occur on corollas, and particularly on the inner scales of leaf-buds: examples—the bulbils of *Achimenes* (fig. 32), the corolla of *Digitalis* (fig. 33), *Lysimachia vulgaris* (fig. 40), *Scrophularia nodosa* (fig. 41), *Bryonia alba* (fig. 42), the inner scales of the winter leaf-buds of the ash, &c. Or the hairs are *torulose*, as in *Lamium album*, the common white Dead-nettle; or *moniliform* or necklace-shaped, as on the stamens of *Tradescantia* (fig. 311), the Marvel of Peru (*Mirabilis*, fig. 309). The transition from these to the branched forms is presented commonly in the simpler forms of the *pappus* of the Compositæ, as in that of the Groundsel, which has *toothed* hairs; in other examples the lateral teeth grow out into branches, as in the species of *Hieracium* and other Compositæ, presenting *pinnate* or *plumose* forms, according to the extent of ramification. The seeds of *Catalpa Bungeana* bear a fringe the hairs of which resemble Pitted Ducts. *Verbascum Thapsus* (Pl. 28. fig. 19) has compound hairs branched at the joints. Compound hairs likewise exhibit the horizontal development; the hairs of the garden Chrysanthemum are horizontal navicular cells, supported on a tall articulated pedicle (fig. 30); the stellate hairs of the Ivy (fig. 27) are compound, and supported on a short stalk-cell. Very varied forms of compound, more or less stellate, hairs occur on the leaves in the orders Jasminaceæ and Oleaceæ. The last form a transition to the scales of the Eleagnaceæ and many Ferns, such as *Acrostichum*.

Fig. 309. Fig. 310. Fig. 311.



Hairs of:—
Mirabilis. Antirrhinum (calyx). Tradescantia (stamen).
Magnified 100 diameters.

The hairs above noticed are mostly solitary. In the Malvaceæ (*Hibiscus*) tufted or stellate groups of hairs are met with; and in the air-cells of *Utricularia* are seen curious groups of four hairs. *Marrubium creticum* is another example of this kind of structure (fig. 47).

Almost all of the above-described forms of hair may contain merely watery colourless or coloured contents; or they may have

one or more of the component cells filled with special oily, resinous, or saccharine secretion. In the latter condition they are termed *glandular* hairs. The characters of these organs are spoken of under the head of GLANDS and SECRETING ORGANS of PLANTS. The gum-resinous secretion found upon the buds of trees (*Æsculus*, &c.) is formed by glandular hairs.

Some of the hairs with watery cell-contents present favourable opportunities for observing the ROTATION of the protoplasm; for example, the young hairs of the stamens of *Tradescantia* or spider-wort; the stinging hairs of nettles also show this when young; and probably it might be observed in all young hairs, where sufficiently transparent and uninjured. One precaution greatly facilitates the observation—namely, to dip the hairs into alcohol for an instant, and immediately plunge them in water; after this operation, the structure is readily wetted by water, and no longer obscured by the abundance of air-bubbles that remain entangled with and adherent to the surface of the fresh hairs. These young hairs likewise exhibit at their apices the various conditions of the contents (nucleus, protoplasm, &c.) of cells multiplying by division (Pl. 47. figs. 8 & 9). The circulation takes place in the dark streaks represented as forming a network connected with the nuclei (*n*).

Stings, such as those of the Nettle (Pl. 28. fig. 8), consist of simple cells having a bulbous base enclosed in a cellular case, formed by the growing-up of the epidermis round the base of the hair; the latter tapers away upward to near the apex, where it again expands into a little globular head. The walls are rather thick and spirally striated. The bulbous base is filled with the irritating liquid, which exudes when the knob-like head is broken off, through the tension of the cellular investment of the sac.

The intimate structure of the hairs of plants presents many points of interest. The cells are of course composed of a cellulose wall, with contents varying according to age and other circumstances. When young, they are always densely filled with protoplasm (Pl. 47. figs. 8 & 9), which becomes gradually excavated by vacuoles, and expanded so as to form a mere reticulation or a few streaks upon the wall, mostly connected with an evident nucleus. The cavity of the cell is then filled, in hairs proper, with watery cell-sap, sometimes coloured, as in the petals and stamens of many flowers, by the same liquid colouring-matter as the cells beneath the epidermis; stings are filled with acrid watery juice,—glandular hairs with various secretions, which, like the watery juices, appear at first in vacuoles, gradually occupying the place of the protoplasm which follows the expanding cell-walls.

Hairs, being epidermal structures, possess a more or less evident cuticular layer, which may be detached by the action of acids (fig. 199, p. 295); sulphuric acid often causes this to separate and expand as a kind of vesicle from the surface of the hair, as is shown in Pl. 28. fig. 13 (*Siphocampylus*); the cuticle of the full-grown moniliform hairs of *Tradescantia* may be separated in like manner (see EPIDERMIS). This *cuticle* also exhibits in many cases the same markings which occur on the surface of the epidermis of certain plants, as *Helleborus*, *Cakile*, &c. (Pl. 28. figs. 9 & 10), consisting of elevated spots, ridges, reticulations, &c. composed entirely of thickenings of the cuticular layer. This is well seen in the hairs of the Boraginaceæ, e. g. *Anchusa* (fig. 17), the Cruciferæ, as of *Farsetia*, *Cheiranthus*, &c., or *Delphinium* (fig. 16). The spiral striæ on the sting of *Urtica urens* (fig. 8) appear to be of similar nature. T. West has described the raised markings upon some hairs as bulgings or wrinkles in the cell-wall.

Finally, it is necessary to mention the remarkable structure of the hairs upon the surface of the seeds and pericarps of certain plants among the Acanthaceæ, Polemoniaceæ, Labiatæ, Compositæ, &c. Those of the ACANTHACEÆ have been spoken of partly under that head and under ACANTHODIUM. They are hairs composed of cylindrical cells, simple (*Ruellia*, Pl. 28. fig. 21), or conjoined into a compound and branched hair (*Acanthodium*, fig. 24), the cell-walls of which receive when young a spiral (fig. 24) or annular (fig. 21) fibrous deposit, and subsequently become partially disorganized; so that, if placed in water in the mature state, the primary cell-wall almost dissolves into a kind of jelly, and the spiral-fibrous structure expands with elasticity. The conditions are similar in *Collomia* (fig. 22), and, according to Schleiden, in *Gilia*, *Ipomopsis*, *Polemonium*, *Cantua*, &c. among the Polemoniaceæ; and somewhat the same in many species of *Salvia* (fig. 23), *Ocymum*, *Dracocephalum moldavicum*, &c. among the Labiatæ. In *Cobæa*

scandens, the spiral-fibrous hairs take rather the form of minute scales, and they do not spontaneously expand elastically (Pl. 28. fig. 20). Among the Compositæ, these spiral-fibrous hairs have been observed on the pericarp of *Ruckeria*, some species of *Trichocline*, *Euriops*, *Mesogramma*, *Doria Chaytiæfolia*, *Oligothrix gracilis*, and some species of *Senecio*. Spiral cells also occur on the seed of *Hydrocharis*. The best way to observe the elastically expanding hairs is to place a thin slice of the skin of the seed on a slide in a little alcohol, which does not soften the cell-wall: when the object is in focus, the addition of a little water causes the gelatinous softening of the cell-walls, the spiral fibres fly out from the surface of the seed-coat and show clearly the character of these beautiful objects. The primary membrane may be detected, even in its gelatinous state, by adding sulphuric acid and iodine, which produce a purplish or violet colour. Further remarks on this head will be found under SPIRAL STRUCTURES.

The hairs on the stigma of *Campanula* are remarkable for the intussusception which is observed to take place in the mature hairs. The filiform processes growing from the under surface of the frondose Hepaticæ, the thallus of Lichens, the prothallium of Ferns, &c., are commonly called radical hairs. In most cases they present no remarkable points of structure; in *Marchantia*, however, peculiar spiral markings have been detected (see MARCHANTIA).

BIBL. Meyen, *Secretions-organe d. Pflanzen*, 1837; id. *Pflanzen-physiol.*; Cohn, *Cuticula*, *Linnæa*, xxiii. 337, 1850; Schleiden, *Müller's Archiv*, 1838; *Beitr. z. Botanik*, Leipsic, 1844, i. 121 (*Sc. Memoirs*); Decaisne, *Ann. Sc. Nat.* 2 sér. xii. 251, pl. 4; Leighton, *Ann. N. H.* vi. 257; Brongniart, *Ann. Sc. Nat.* 2 sér. xii. 244, pl. 4; Prillieux, *Ann. Sc. Nat.* 4 sér. v. 5; Tuffen West, *Qu. Mic. Jn.* vii. 22; Weisse, *D. Pflanzenhaare*, 1867; Hanstein, *Bot. Zeit.* 1868, 697; Rauter, *Trichomgeb.* 1871; Martinet, *Ann. Sc. Nat.* 1872, xiv.; Sachs, *Bot.* 163.

HALAC'ARUS, Gosse.—A genus of marine Acarina.

Char. Body sometimes covered with a dorsal shield; rostrum bulbous, pointed; palpi terminated by a fang-like claw; legs formed for walking, arising from the outer margin of the body, directed two pairs forwards and two backwards, and with a pair of hooks.

Five species: found crawling upon seaweeds at low water, or in dredgings.

BIBL. Gosse, *Mar. Zool.* i. 177; Murray, *Econ. Entom.* 205 (figs.).

HALARACH'NE, Allman.—A genus of marine Acarina; family Gamasea.

Body elongate subcylindrical, with an anterior dorsal plate.

H. halichœri. In the posterior nares of a seal (*Halichœrus gryphus*); length 1-8″.

BIBL. Allman, *Ann. N. H.* 1847, xx. 47; Murray, *Econ. Ent.* 167 (figs.).

HALE'CIIDÆ, Hincks.—A family of Hydroid Zoophytes.

Gen.: *Halecium* and *Ophiodes*.

HALE'CIUM, Oken.—A genus of Hydroid Zoophytes, family Sertulariidæ.

Distinguished by the plant-like polypidom, the stem consisting of numerous parallel capillary tubes, and the cup-like nearly sessile cells arising alternately on opposite sides of the stem, one under each joint.

H. halecinum. Vesicles oval or oblong. Common on shells and stones in deep water; 4-10″ high.

H. Beanii. Vesicles calceoliform. Rare.

H. muricatum. Vesicles spinous.

5 other species.

BIBL. Johnston, *Brit. Zooph.* 58; Hincks, *Hydroid Zooph.* 220.

HALICHOND'RIA, Flem.—A genus of SPONGES.

HAL'IDRYS, Lyngb.—A genus of Fucaceæ (Fucoid Algæ), containing one British species, *H. siliquosa*, common on rocks and stones somewhat above low-water mark. It is readily distinguished by its pod-like septate air-vessels. The fructification, which is terminal on the branches, much resembles that of FUCUS, except that the interior of the receptacles is filled up with firm polygonal cellular tissue. The antheridia, moreover, are terminal on their pedicels, often in tufts, short in form, and intermixed with spore-sacs in the same conceptacle.

BIBL. Harvey, *Br. Mar. Alg.* 15, pl. 1 C; Thuret, *Ann. Sc. Nat.* 3 sér. xvi. 8, pl. 3.

HALIO'NYX, Ehr.—A genus of Diatomaceæ.

Char. Frustules single; valves equal, circular, surface radiate, the rays not commencing at the umbilicus; no internal septa. Marine.

H. senarius. Rays six, the intervening spaces with shorter rays of equal length parallel to the larger, and with transverse

laxly cellular lines; umbilicus punctate, entire; diam. 1-720″.

H. undenarius (Pl. 18. fig. 51). Rays eleven or twelve.

Bibl. Ehr. *Ber. Berl. Akad.* 1844, 198.

HALISAR'CA, Duj. (Hymeniacidon, Bowerbk.).—A genus of marine Sponges.

Forms a thin semitransparent gelatinous amber crust on rocks and shells, with indistinct oscula and pores.

H. Dujardinii. The only species.

Bibl. Johnston, *Br. Sponges*; Gosse, *Mar. Zool.* i. 6; Bowerbank, *Br. Spong.* ii. 224.

HALIS'ERIS, Tozzetti. — A genus of Dictyotaceæ (Fucoid Algæ), containing one British species, with a brownish olive, sometimes forked frond with a midrib, from 4″ to 1′ high, having a very powerful offensive smell when fresh. The fructification is produced in sori, arranged in lines on each side of the midrib, or scattered, containing large spores.

Bibl. Harvey, *Mar. Alg.* 36, pl. 6 B.

HALOCY'PRIS, Dana.—A marine Ostracode, with very thin, subquadrate, saddle-shaped valves, beaked in front at the upper angle. The closely allied *Conchœcia*, Dana, has longer and subrectangular valves. Both are related to *Cypridina*, and have two pairs of feet, weak upper antennæ, distinct mandibles, large frontal tentacle, and no eyes.

Living in the Atlantic and Mediterranean.

Bibl. Dana, *Expl. Exped., Crust.* 1301; Brady, *Linn. Tr.* xxvi. 409.

HALTE'RIA, Duj.—A genus of Infusoria, family Halterina.

Char. Body almost spherical or top-shaped, with an anterior circle of cilia, and a peripheral row of longer slender setæ, which by sudden contraction produce a leaping motion. Freshwater.

H. grandinella=*Trichodina grandinella*, Ehr. (Pl. 50. figs. 11, 12); greatest breadth, 1-850″.

H. volvox; like *H. grandinella*, but with a second peripheral row of shorter and closer cilia. 3 other species.

Stein points out the resemblance of this animalcule to the swarm-germs of an *Acineta* found upon *Cyclops*.

Bibl. Dujardin, *Inf.* 414; Stein, *Inf.*; Cl. & Lach. *Inf.* 369; Kent, *Inf.* 631.

HALTERI'NA, Cl. & Lach.—A family of Peritrichous Infusoria.

Char. Free, globose or flask-shaped, with an anterior circle of cilia, and sometimes a peripheral row of longer setæ, which by their sudden contraction produce a leaping motion.

Gen.: *Halteria*, with both cilia and setæ; *Strombidium*, with cilia only; *Mesodinium*, with a proboscis and setæ; *Acarella*, with cilia and a carapace; *Arachnidium*, with stout tentacle-like cilia; and *Didinium*, with an anterior and posterior circle of cilia.

HAL'TICA, Ill.—A genus of Coleopterous Insects; fam. Galerucidæ.

H. nemorum, the "turnip-fly." Oblong-ovate, black; elytra greenish black, with a broad uninterrupted sulphur-yellow streak, not reaching the apex. Movement jumping.

Bibl. Stephens, *Brit. Coleopt.* 291.

HALYME'NIA, Ag.—A genus of Cryptonemiaceæ (Florideous Algæ), containing one British species, found on the southern shores. It is a somewhat palmate, membranous, rose-coloured sea-weed, usually from 6 to 12″ long, composed of a double membrane, the layers being separated by a loose network of jointed filaments. The fructification consists of favellidia buried in the frond, attached to the inner surface of the membranous laminæ, scattered all over the frond, appearing to the naked eye like red dots.

Bibl. Harvey, *Brit. Alg.* 148, pl. 19 D.

HAPALOSI'PHON, Näg.—A genus of Oscillatoriaceæ. Filaments branched, formed of a single row of cells, with delicate coloured, indistinctly lamellar sheaths.

Four species; on freshwater plants. (Rabenhorst, *Fl. Alg.* 283.)

HAPLA'RIA, Link. See Botrytis *grisea*.

HAPLOMIT'RIUM, Nees.—A genus of Jungermannieæ (leafy Hepaticæ), containing one British species, *H.* (*Jungermannia*) *Hookeri*, an Alpine plant, which has been carefully studied by Gottsche. It is remarkable for having leaves (without *amphigastria*) inserted on all sides of the stem. The terminal capsule emerges at length from a large oblong fleshy epigone (fig. 328). The antheridia (fig. 323) occur in the axils of the leaves; they have a double coat, the interior of which consists of reniform cells (fig. 322), which become isolated and more or less dissolved. The spermatozoids, produced in minute vesicles (fig. 324), resemble those of the Mosses.

Bibl. Hooker, *Brit. Jungermanniæ*, pl. 54; Ekart, *Syn. Jung.* pl. fig. 65; Endlicher, *Gen. Plant.* No. 474–3; Gottsche, *Nova Acta*, xx. 265, pls. 13–20.

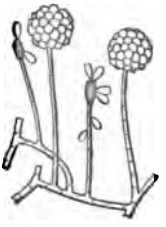
HAPLOPHRAG'MIUM, Reuss. — A sandy Lituoline Foraminifer, either nautiloid or crozier-shaped, with simple or compound aperture and undivided chambers. Recent and fossil.

Bibl. Reuss, *Sitzungsb. Ak. Wien*, xliv. 381; Brady, *Mic. Jn.* n. s. xix. 29.

HAPLOSTI'CHE, Reuss. See Lituola.

HAPLOT'RICHUM, Link.—A genus of Mucedines (Hyphomycetous Fungi), intermediate in structure between *Botrytis* and *Aspergillus*. The spores are developed from a capitate cell terminating the septate erect fertile filaments (fig. 312).

Fig. 312.



Haplotrichum roseum. Magn. 200 diams.

Bibl. Corda, *Ic. Fung.*; Nees, *Syst. Pilze*, pl. 4; Fries, *Sum. Veget.* 470.

HARPAC'TICUS. See Arpacticus.

HARPIRHYN'CHUS, Még.—A genus of Trombidina (Acarina).

H. nidulans, in the dilated feather-follicles of the lark and green-finch. (Mégnin, *Paras.* 243, fig.).

HAR'TEA, Wright.—A genus of Alcyonidiidæ.

Polype solitary; body cylindrical, fixed at the base; tentacles 8, knobbed at their base; basal portion of body thickly studded with small star-shaped spicula; base and body of tentacles with long dendritic spicula; mouth central, with 2 lips; somatic chambers 8.

H. elegans. Height 3-4″. White, base dark. West coast of Ireland.

Bibl. E. S. Wright, *Qu. Mic. Jn.* 1865, v. 213 (pl.).

HARVEST-BUG. Trombidium *autumnale*.

HASSALLIA, Berk. See Sirosiphon.

HASTERIGERI'NA, Thomson. — Described by Brady as scarcely separable from *Globigerina* (W. Thomson, *Proc. R. S.* xxiv. 534; H. Brady, *Mic. Jn.* 3, xix. 79).

HAUERI'NA, D'Orb. — One of the *Miliolidæ*, growing on one plane, subdiscoidal, and characterized by a cribriform aperture.

H. compressa (Pl. 23. fig. 8). Fossil in the Tertiary beds; living in tropical seas; rare on the British coast.

Bibl. Carpenter. *Introd. For.* 81.

HAUSTO'RIA.—A term applied to certain short processes springing from the basal fibres of the hyphæ of moulds, while traversing the intercellular passages of the host-plants; they are often expanded at the ends. They penetrate the parenchymatous cells, and absorb their contents. They may be readily studied in *Cystopus*.

Bibl. Brefeld, *Schimmelpilze*; De Bary, *Beiträge*; Sachs, *Bot.* 279 (figs.).

HAVERSIAN CANALS. See Bone.

HEART.—The muscular fibres of the heart present certain peculiarities. The primitive bundles are more slender than usual; they frequently anastomose, and contain normally a few minute granules of fat: the transverse striæ are also often indistinct. In disease the fatty matter is often extremely abundant (Pl. 38. fig. 14 *a*), and the striæ are more or less obliterated.

Bibl. Kölliker, *Mik. An.* ii.; Förster, *Path. An.*; Wedl, *Path. Hist.*; Quain, *Med. Chir. Tr.* 33; Rokitansky, *Path. An.*

HEDRÆOPHY'SA, Kt. = sessile *Bicosœca*. One sp., Jersey. (Kent, *Infus.* 274).

HEDWIG'IA, Hook.—A genus of Mosses. See Zygodon.

HEIBER'GIA, Grev.—A genus of Diatomaceæ.

Char. Fr. compressed, quadrilateral, cellulate, with a punctate surface of the angles, where they probably cohere: valves with one longitudinal and several transverse costæ, the longitudinal one terminating at each end in a blank space.

A. Barbadensis (Pl. 52. fig. 4). Barbadoes deposit.

Bibl. Grev. *Mic. Trans.* 1865, v. 100.

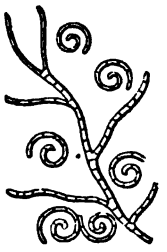
HELICO'MA, Corda.—A genus of Dematiei (Hyphomycetous Fungi), with the spores curled into a spiral. Berkeley considers the distinction between *Helicoma* and *Helicosporium* scarcely tenable, and Fries includes *Helicoma Mülleri*, Corda, under *Helicosporium*. This plant has been found on dead wood in this country.

Bibl. Corda, *Ic. Fung.* i. pl. 4. fig. 219; Berkeley and Broome, *Ann. N. H.* 1851, vii. 98; Fries, *Sum. Veget.* 500.

HELICOSPO'RIUM, Nees.—A genus of Dematiei (Hyphomycetous Fungi), growing on decayed wood, nearly related to *Helicoma* and *Helicotrichum*. *Helicoma* and *Helicosporium* are described as having erect fertile filaments, *Helicotrichum* creeping

branched filaments; but the distinctions are obscure, as also those between *Helicoma* and *Helicosporium*, the first of which should have the spirals closed, the latter open. Fries and Berkeley both include *Helicotrichum* under *Helicosporium*. British species:

Fig. 313.



Helicosporium pulvinatum.

Magn. 200 diams.

H. pulvinatum, Fr. (fig. 313). Forming a blackish or olive pulvinate stratum over wood, with slender branched filaments, bearing yellowish-green strings of sporidia coiled up into a spiral of about three turns, very fugacious (*Helicotrichum pulvinatum*, Nees).

H. vegetum, Fr. Widely pulvinate-effused, subolivaceous, at length black; fertile filaments erect, stiff, subulate; spores coiled into a ring, 3-septate, greyish green.

Bibl. Berk. *Hook. Br. Fl.* vol. ii. pt. 2. 335; *Ann. N. H.* 1850, vi. 434; vii. 98; Fries, *Syst. Myc.* iii. 353; *Sum. Veg.* 500; Corda, *Sturm, Deutschl. Flora*, 3 ser. ii. pls. 15 & 16; Nees, *Nova Acta*, ix. 246, pl. 5. fig. 15; *Syst. Mycol.* 68, fig. 69.

HELICOSTE'GIA.—An order of Foraminifera, according to D'Orbigny's system, comprising those coiled spirally on a single axis. This feature, however, is common to several genera which have distinct characters of structure and habit, and has ceased to be regarded as typical.

HELICOS'TOMA, Cohn.—A genus of Holotrichous Infusoria = *Nassula* with the pharynx hooked at the end. *H. oblonga*; in salt water; l. 1-125″. (Kent, *Infus.* 501).

HELICOT'RICHUM, Nees. See Helicosporium.

HELIOPEL'TA, Ehr.—A genus of Diatomaceæ.

Char. Frustules single (?); valves circular, with imperfect radiating septa, the alternate intermediate portions of the valve being depressed; markings absent in the centre, but as many large submarginal apertures (?) present as there are rays, and numerous erect opposite submarginal spines on each side. The spines connect the pairs of young frustules.

H. metii. Frustules with six septa and rays, three of the intervals raised and coarsely cellular, the alternate ones impressed with fine decussating lines, the limb of the radiate margin broad; marginal spines in the middle of each cellular interval one or three, in the others two or four; umbilical star slightly angular; diameter 1-370″. Bermuda.

H. Leeuwenhoeckii, Pl. 25. fig. 4. Three other species, with a different number of rays.

The different appearances of the markings upon the elevated and depressed portions of the valves evidently arise from the existence of the ordinary depressions seen naturally by oblique and direct light.

Bibl. Ehrenberg, *Berl. Ber.* 1844, 202; Greville, *Mic. Tr.* 1866, vi. 5 (*new sp.*).

HELMIN'THOSPO'RIUM, Link. — A genus of Dematiei (Hyphomycetous Fungi), growing on rotten wood &c., of which numerous species are found in Britain. Tulasne regards this genus as consisting of stylosporous forms of Sphæriacei. Currey refers to this genus Corda's *Dactylium* (Dendryphium) *fumosum*. The mycelium is often somewhat gelatinous or indistinct; on it arise (often aggregated) erect, rigid, septate filaments (*fibres*), on the summits of which stand large, often club-shaped septate spores. British species:

H. macrocarpum, Greville (*Crypt. Fl.* pl. 148. fig. 1).

H. subulatum, Nees (*Nova Acta*, ix. pl. 5. fig. 13).

H. Clavariarum, Desmazières (*Ann. Sc. Nat.* 2 sér. ii. pl. 2. fig. 2).

H. velutinum, Link (Grev. *Crypt. Fl.* pl. 148. fig. 2).

H. fusisporium, Berk. (*Br. Flora*, vol. ii. part 2. 336).

H nanum, Nees (*Nova Acta*, ix. pl. 5. fig. 13 B; *System.* fig. 65).

H. simplex, Kunze (Nees, *l. c.* fig. 11).

H. Tiliæ, Fr. (Berkeley, *Ann. N. H.* vi. pl. 13. fig. 18).

H. folliculatum, Corda (*Ic. Fung.* i. pl. 3 fig. 180).

H. obovatum, Berk. (*Ann. N. H.* vi. pl. 13. fig. 19); on old wet planks.

H. delicatulum, Berk. (*l. c.* fig. 20); on stems of Umbelliferæ.

H. Smithii, Berk. and Broome (*Ann. N. H.* 1851, vii. pl. 5. fig. 5).

H. turbinatum, Berk. and Br. (*l. c.* fig. 6).

H. Rousselianum, Montagne (*Ann. Sc. Nat.* 3 sér. xii. 300).

H. stictitum, Berk. and Br. (*Ann. N. H.* 1854, xiii. pl. 15. fig. 10).

Bibl. Berkeley, *Br. Fl.* iii. pt. 2, 336; Fries, *Syst.* iii. 354, and *Sum. Veget.* 500

(1849); Currey, *Qu. Mic. Jn.* v. 115; Tulasne, *Ann. Sc. Nat.* 4 sér. v. 109.

HELMINTHOS'TACHYS, Kaulf.—A genus of Ophioglossaceous Ferns, distinguished by the complex spikes bearing crested sporanges.

Fig. 314. Fig. 315.

Helminthostachys zeylanica.

Fig. 314. Fragment of a spike with sporanges. Magnified 10 diams.
Fig. 315. A portion still more magnified (20 diams.).

HELVEL'LA, L.—The typical genus of Helvellacei.

Several species occur in this country, amongst which *H. lacunosa* and *H. crispa* are esculent.

BIBL. Fr. *Syst. Myc.* vol. ii. 13; Berk. *Outl.* 358; Hooker, *Syn.* 447.

HELVELLA'CEI.—A family of Ascomycetous Fungi, comprised in Discomycetes, approaching the Hymenomycetes in outward form, but distinguished at once by their fructification. See ASCOMYCETES, HELVELLA, SPATHULARIA, LEOTIUM, STICTEI, PROPOLIS.

HEMELYT'RA.—The anterior pair of wings of the Heteropterous division of the Hemiptera. See INSECTS.

HEMERO'BIUS, Linn.—A genus of Neuropterous Insects.

Hemerobius (*Chrysopa*) *perla*, one of the lace-winged flies, has very thin, transparent, and beautifully netted iridescent wings, in which the circulation can be well observed; the wings also exhibit well the tracheæ in the veins. The larva feeds upon Aphides.

BIBL. Westwood, *Intr.*; Bowerbank, *Entom. Mag.* iv.

HEMIAU'LUS, Ehr.—A genus of Diatomaceæ.

Char. Frustules single, compressed, subquadrate, with two tubular processes on each side, the ends of those (the shorter) on one side being open, the others closed; not constricted at the sides.

H. antarcticus (Pl. 25. fig. 3).

BIBL. Ehrenberg, *Berl. Ber.* 1844, 199; Greville, *Ann. N. H.* xvi. 5; id. *Mic. Tr.* 1865, 26, 52, 101.

HEMIDIN'IUM, Stein.—A genus of Cilio-flagellate Infusoria: free, flagellum single; a fringe of cilia in a groove extending halfway round the body. *H. nasutum*, yellow; freshwater. (Kent, *Infus.* 442.)

HEMIDIS'CUS, Wall.—A genus of Diatomaceæ.

Char. Fr. free; valves arcuate, with a median marginal inferior nodule; areolation hexagonal, radiate.

H. cuneiformis. From *Salpæ*, Bay of Bengal and Indian Ocean.

BIBL. Wallich, *Mic. Tr.* 1860, viii. 42 (fig.).

HEMILEI'A, Berk.—A genus of Uredineæ (Hypodermous Fungi), characterized by the meniscoid spores, which are smooth within, but strongly granulated without. *H. vastatrix*, the Coffee-fungus, is extremely destructive to the Coffee-plants, forming orange-brown spots upon the leaves. One or two other Rubiaceæ are attacked by a distinct species. In germination, a form of *Penicillium* has often been developed, but this is probably accidental.

BIBL. Berk. & Br., *Jn. Linn. Soc.* xiv. 93; Dyer, *Qu. Mic. Jn.* 1880, xx. 119 (figs.); Abbay, *Jn. Linn. Soc.* xvii. 176; Ward, *Mic. Jn.* xxii. (figs.).

HEMIONI'TIS, Linn.—A genus of Grammitideæ (Polypodiaceous Ferns), with a very elegant reticulated arrangement of the sori.

Eight species; exotic. (Hooker, *Syn. Fil.* 398.)

HEMIOPH'RYA.—A genus of Acinetina (Kent, *Inf.*).

HEMIP'TERA.—An order of INSECTS.

HEMIP'TYCHUS, Ehr. See ARACHNOIDISCUS.

HEMITE'LIA, Presl.—A genus of Cyathæous Ferns. Exotic. (Hook. *Syn.* 27.)

HEMIZOS'TER, Ehr.—(Ehrenberg, *Ber. Berl. Ak.* 1844, 199).

HEMP.—The ordinary name of the fibre of *Cannabis sativa*, consisting of the liber-fibres of this plant (Pl. 28. fig. 6). It is applied to some other substances used for the same purposes, *e. g.* Manilla hemp (the fibre of MUSA) &c. See TEXTILE FIBRES and LIBER.

HENDERSO'NIA, Berkeley (*Sporocadus*, Corda, in part).—A genus of Sphæronemei (Stylosporous Fungi), interesting as having furnished one of the earliest discovered examples of two forms of fructification, leading to the abolition of the distinction between Coniomycetous and Ascomycetous Fungi (CONIOMYCETES). Berkeley has seen two conditions of spores in *H. mutabilis*, and states that Fries informs him of

Fig. 316.

Hendersonia.
Spores on the perithecium.
Magnified 200 diams.

the observation of asci and septate naked spores (*stylospores*) conjointly in *Hendersonia Syringæ*. Several British species have been described. They form dark spots or patches on the stems of herbs or twigs of trees,—the dark matrix having a *perithecium* excavated in it, lined by a gelatinous stratum, on which stand stalked fusiform septate spores (fig. 316).

H. elegans, Berk. (Pl. 27. fig. 11) (*Ann. N. H.* 1840, vi. pl. 11. fig. 9). On the culms of reeds.

H. macrospora, Berk. and Broome (*l. c.* 2nd ser. v. 373). On dead twigs of *Philadelphus*.

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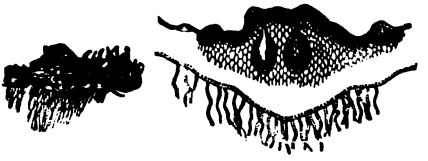

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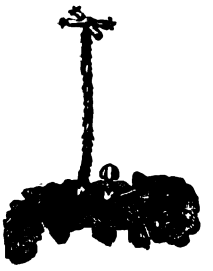

Lunularia vulgaris.
A frond in fruit. Nat. size.

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Fig. 320. Radula complanata. Magn. 5 diams.
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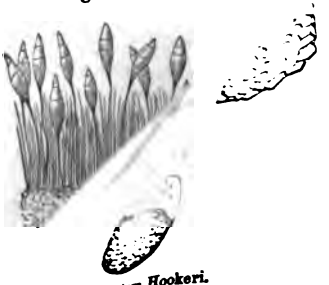
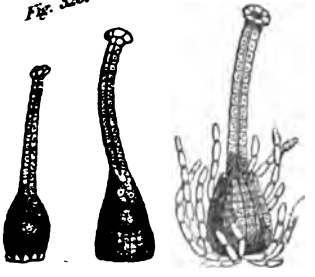
Fig. 316.



Haplomitrium Hookeri.
Antheridia. Magn. 30 diams.
Fragment of wall of antheridia; the reniform cells lining to the inner layer. Magn. 200 diams.
Spermatozoids from ditto. Magn. 200 diams.

Fig. 325. Fig. 326. Fig. 327.



Marchantia polymorpha.
Archegonia in various stages.
Magnified 100 diameters.

The *archegonia* or *pistillidia* are likewise developed in various places, indicated hereafter in the tabular view of the families. They consist of a kind of flask-shaped cellular case (figs. 325 to 327), enclosing at first a single cell (*embryonal cell*), which subsequently grows into a sporange, apparently after one or more of the spiral filaments of the antherids have come in contact with it, by passing into the neck of the flask-shaped sac (*epigone*). The embryonal cell becomes

BIBL. Berkeley, and ... into a globular *Ann. N. H.* iv. 43; ... acquires various forms 319; Fries, *Sum* ... era and families. The *Sc. Nat.* 4 sér. ... s for a long time with the HEPAT... psule, completely enclosing it (Cryptog...); but after a time the latter bursts of sm... inha... or

Fig. 328.

Haplomitrium Hookeri.
Young sporange enclosed in the epigone.
Magnified 20 diameters.

through the top of the *epigone*, which thus forms a kind of sheath round the base of the sporange or its stalk, and is called the *vaginule*. The epigone may tear irregularly, so as to form an irregular *vaginule* or *calyx*, or regularly, so as to present a circle of teeth; or it may be slit horizontally in a circle, and half of it carried up by the sporange, which it thus surmounts as a hood or *calyptra*. This epigone is sometimes surrounded by another envelope called the *perigone*. This originates at a later period and in a different way, since it gradually springs up as a circular sheath around the base of the epigone, and by continued growth comes to surround it as a kind of cup, like the corolla of a flower (fig. 320). In *Marchantia*, only one archegone is found in each perigone; the perigones of Jungermannieæ always enclose several, but only one is developed into a sporange. In some kinds, as *Sarcoscyphus*, there are always several archegones in a perigone, and two or three produce sporanges. Sometimes the archegones, with or without perigones, are solitary; more frequently they are in groups. Whether solitary or grouped, they may have a further envelope composed of slightly modified leaves, free or confluent together; these are the *perichætial leaves*, and constitute the *perichæte*. When both *perichæte* and *perigone* exist, it is easy to determine which is which; but when only one exists, the history of development alone gives the key; the

richæte is always developed before the
hegones it encloses, while the perigone,
ready stated, grows up round the arche-
during its development into a sporange,
bsent at the time of the first appear-
that organ. In fig. 320 the base of
el is seen to rise out of a toothed
alyx or *epigone*), which is enclosed
perigone, outside of which are
perichætial leaves.
re developed from the embry-
the archegone varies much in
rect condition. In Jungermannieæ it
is mostly an oval body borne on the extremity of a delicate thread-like stalk springing out of the *vaginule* (fig. 320). The oval body splits down from the summit, when ripe, into four valves, which spread open more or less in the form of a cross (figs. 320-1), or bursts irregularly. The cells of the valves exhibit very elegant spiral-fibrous structure, like that of the walls of anthers (see SPIRAL STRUCTURES). This kind of sporange discharges minute spores (see SPORES) and *elaters*, slender tubular cells containing a spiral filament (Pl. 40. fig. 38), both forming very interesting microscopic objects.

In the different frondose forms the sporanges present very varied conditions. The archegones of ANTHOCEROS send up a filiform sporange, which is two-valved and contains a *columella* (fig. 24, p. 58). In TARGIONIA and some others the capsule is almost sessile, and bursts irregularly. In RICCIA, where the archegones are imbedded in the frond, the sporange is a sessile globose body, with the calyptra adherent, never bursting regularly, but emitting the spores by decay. In SPHÆROCARPUS, also, the calyptra is permanent as a cellular sac, inside of which the sporange ripens into an indehiscent globular body, emitting the spores only by decay. In *Marchantia*, *Fegatella*, *Lunularia*, *Grimaldia*, &c., the archegones are produced on fleshy receptacles elevated upon stalks, and the sporanges are formed on the underside of these receptacles (fig. 219. p. 317, figs. 330, 333, 335), which are of varied forms, &c. The sporanges on these either burst by valves (fig. 331), or by circumscissile dehiscence throw off a lid, as in *Fimbriaria* (fig. 335).

The frondose forms do not all produce *elaters*, and have not all the spiral fibres in the cells of their walls. The exceptions are the Ricciæ; and the elaters of *Anthoceros* are rudimentary. In *Marchantia* the

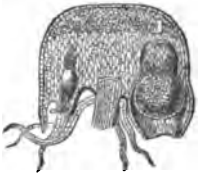
Fig. 329. Fig. 330.

Fig. 331.

Lunularia vulgaris.

Fig. 329. Section of a receptacle, unripe.
Fig. 330. More advanced sporange, emerged from the epigone.
Fig. 331. A burst sporange.
Magnified 20 diameters.

Fig. 332. Fig. 333.



Grimaldia barbifrons.

Fig. 332. Fertile plant. Magn. 2 diams.
Fig. 333. Section of the receptacle, with an abortive archegone on the left side, and a half-ripe sporange still enclosed in the epigone on the right. Magn. 20 diams.

Fig. 334. Fig. 335.

Fimbriaria tenella.

Fig. 334. Receptacles with closed epigones. Magn 10 diams.
Fig. 335. Two perigones, one with the epigone closed, the other with the teeth of the epigone open, showing the bursting sporange. Magn. 20 diams.

elaters are highly developed (Pl. 40. figs. 36, 37), also the spiral tissue of the valves

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Fig. 316.

Hendersonia.
Spores on the perithecium.
Magnified 200 diams.

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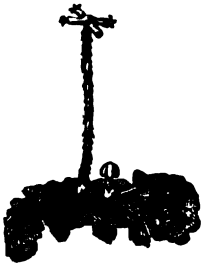

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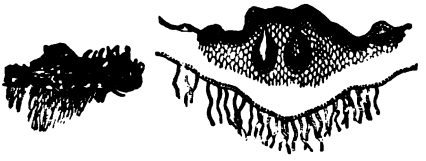

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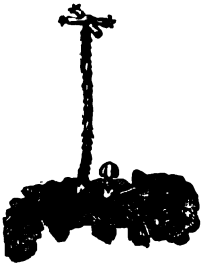

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Fig. 316.

Hendersonia.
Spores on the perithecium.
Magnified 200 diams.

the observation of asci and septate naked spores (*stylospores*) conjointly in *Hendersonia Syringæ*. Several British species have been described. They form dark spots or patches on the stems of herbs or twigs of trees,—the dark matrix having a *perithecium* excavated in it, lined by a gelatinous stratum, on which stand stalked fusiform septate spores (fig. 316).

H. elegans, Berk. (Pl. 27. fig. 11) (*Ann. N. H.* 1840, vi. pl. 11. fig. 9). On the culms of reeds.

H. macrospora, Berk. and Broome (*l. c.* 2nd ser. v. 373). On dead twigs of *Philadelphus*.

H. arcus, Berk. and Br. (*l. c.*). On Box twigs.

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H. macropus, Berk. and Br. (*l. c.*). On dead leaves of *Carex*.

H. typhoidearum, Desmazières (*Ann. Sc. Nat.* 3 sér. xi. 344). On dead stems of *Typha*, &c.

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H. fibriseta, Berk. (*Hooker's Jn. Bot.* iv. 43). On birch planks.

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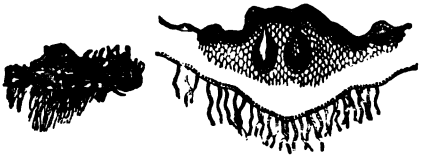

Fimbriaria fragrans.

Fig. 317. Lobe of a frond. Nat. size.
Fig. 318. Section of frond, showing two immersed antheridia. Magnified 40 diams.

Lunularia (fig. 319), &c., likewise possess thick cellular fronds. In *Riccia* the frond also presents a reticulated upper face provided with stomata; but the form of the entire frond is usually elongated and bifurcated, and a slight groove runs along the middle line, almost like a mid-nerve. This central line exhibits a difference in the internal cellular structure, since it is composed of elongated cells, while the surrounding green substance is composed of spherical cells, such as constitute the entire mass enclosed between the upper and lower epidermis of the frond of *Marchantia*. The groove on the upper face (of *Riccia*) corresponds to a rib on the lower face, from which arise most of the radical filaments,

while they are scattered indiscriminately over the lower face of *Marchantia*; and from this line also arise the little bodies resembling minute leaves, called *amphigastria*. If we suppose the frond of *Riccia* elongated and the mid-nerve more strongly marked, we have the likeness of *Blyttia Lyelli* (fig. 62, p. 106); while if this latter were notched down to the rib at intervals along each side, we should have the stem with two parallel rows of leaves, as in the Jungermannieæ.

Fig. 319.

Lunularia vulgaris.
A frond in fruit. Nat. size.

The line of insertion of the leaves is seldom exactly parallel with the axis of the plant, and very rarely at right angles. In most cases it is more or less oblique, and the obliquity is in reverse direction at the two sides of the stem, so that the lines of insertion of two succeeding leaves would meet, if prolonged across the stem, in the form of a V (fig. 320).

The leaves are very frequently imbricated, and they overlap in two ways: either each leaf covers with its lower edge a little of the leaf below it, or each leaf overlaps a little of the base of the leaf above it. In the first case, the leaves are called *succubous* (fig. 320), in the second *incubous* (fig. 321). The leaves vary much in form, and are often deeply toothed or bilobed, and form exceedingly elegant objects under the microscope. The leaves are accompanied in many cases, chiefly in the Jungermannieæ, by stipule-like leaflets, called *amphigastria*, situated at the underside of the stem.

These plants are reproduced by dust-like grains called *spores*, by minute cellular nodules called *gemmæ*, and by *innovations*, *i. e.* new lobes growing out from the margins of the old fronds, or buds in the axils of leaves, or on confervoid branches set out from the stem.

The *gemmæ* of *Marchantia polymorpha* are produced in elegant membranous cups, with a toothed margin, growing on the upper surface of the frond, especially in very damp and imperfectly lighted situations; they are little cellular nodules at first attached by a stalk, and at a certain period fall off and grow up into a new frond. (See MARCHANTIA.)

Fig. 320. Fig. 321.

Fig. 320. Radula complanata. Magn. 5 diams.
Fig. 321. Plagiochila undulata. Magn. 5 diams.

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Spores on the perithecium.
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Fimbriaria fragrans.

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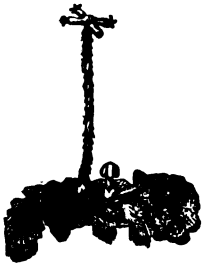

Lunularia vulgaris.
A frond in fruit. Nat. size.

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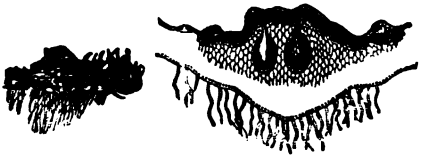

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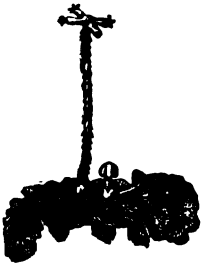

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are found attached to aquatic insects (fig. 29 *f*), as *Nepa*, *Dytiscus*, &c.

H. geographica. Body spherical, black, with spots and yellow points; palpi red, acute; legs shorter than the body, black, but red at the ends.

H. concharum. Inhabits the pallial cavity of the Naiades.

BIBL. Dugès, *An. Sc. Nat.* 2 sér. i.; Gervais, *Walckenaer's Arachn.* iii.; Koch, *Deutschl. Crustac.*; Murray, *Ec. Ent.* 157.

HYDRACH'NEA (Water-spiders).—A family of Acarina.

Palpi with the last joint unguiculate or spinous; two or four distinct ocelli; coxæ broad, legs generally ciliated, natatory, the posterior longest, tarsi with two claws.

The characters of the genera must be sought under the individual heads. See ARRENURUS, ATAX, DIPLODONTUS, EYLAÏS, HYDRACHNA, and LIMNOCHARES.

HYDRACTIN'IA, V. Bened.—A genus of Hydroid Polypi, of the family Hydractiniidæ.

Char. Polypidom incrusting; polypes claviform, tentacles in a single whorl at the base of a conical proboscis.

H. echinata. Polypidom rough with serrated spines, whitish fleecy. On univalve shells tenanted by the hermit crab.

BIBL. Hincks, *Brit. Zooph.* p. 19.

HYDRALLMAN'IA, Hincks.—A genus of Hydroid Zoophytes, fam. Sertulariidæ.

H. falcata = *Plumularia falc.* Johnst.

BIBL. Hincks, *Brit. Zooph.* p. 273.

HYDRAN'THEA, Hincks.—A genus of Hydroid Polypi, fam. Atractylidæ.

H. margaritacea, white; on *Flustra foliacea.*

BIBL. Hincks, *Ann. N. H.* 1863, xi. 45; and *Br. Zooph.* 99.

HYDRIA'NUM, Rab.—A genus of Palmellaceous Algæ.

Char. Cells resembling those of *Characium*, but open at the ends; endochrome contracted, ultimately becoming resolved into 2–4–8 zoogonidia. *H. ovale* (Pl. 52. fig. 5).

12 species: freshwater; adherent to other Algæ.

BIBL. Rabenhorst, *Fl. Alg.* iii. p. 87.

HY'DRIAS, Ehr.—A genus of Rotatoria, of the family Philodinæa.

Char. Eyes absent; neither proboscis present, nor horn-like processes on the foot; rotatory organs two, placed at the ends of two anterior processes of the body.

H. cornigera (Pl. 43. fig. 39). Body ovate, hyaline; foot narrowed into the form of a slightly forked tail; freshwater; length 1-190".

Probably a young and imperfectly examined *Philodina.* Found in Egypt.

BIBL. Ehrenberg, *Infus.* p. 488.

HY'DRIDÆ.—A family of Zoophytes, order Hydroida.

It contains the single genus *Hydra.*

HYDROCHARIDA'CEÆ.—A familyof Monocotyledonous Flowering Plants growing in water, interesting to the microscopist, as affording very favourable opportunities of viewing the circulation or *rotation* of the cell-contents. The leaves of *Vallisneria spiralis*, an Italian plant, which is readily grown in jars of water indoors, are very frequently used for this purpose; the leaves and sepals of *Anacharis Alsinastrum*, a North American plant, now naturalized in streams in many parts of Britain, also show the circulation well. The extremities of the roots of *Hydrocharis morsus-ranæ*, a plant common, floating on the surface, in broad permanent ditches, are likewise adapted for the purpose. The circulation consists of the flowing movement of a layer of colourless protoplasm over the inner surface of the walls of the cells. Where, as in the leaves of *Vallisneria* and *Anacharis*, the cells contain green globules of chlorophyll, these mostly adhere to the circulating mass, and are carried round with it. The phenomenon may be observed in uninjured young leaves simply immersed in water by focusing carefully; but in *Vallisneria* it is seen more clearly in slices taken carefully parallel to the surface of the leaf. The circulation lasts a long time in these separate fragments if they are kept wet. Sometimes it is arrested by the preparation; in such cases the application of a gentle heat often causes it to recommence. It may be observed with a power of 200 diameters; but a higher is requisite for minute investigation. (See ROTATION.)

HYDROCHOREUTES, Koch, = *Hydrachna*, pt.

HYDROCO'LEUM, Kütz.—A genus of Oscillatoriaceæ (Confervoid Algæ), corresponding to aquatic species of *Chthonoblastus. H. helveticum* (Pl. 52. fig. 6).

11 European species.

BIBL. Kützing, *Phyc. Gen.* 196; Rabenhorst, *Fl. Alg.* ii. p. 149.

HYDROCY'TIUM, Al. Braun.—A genus of unicellular Algæ, separated from that author's *Characium* on account of the whole

contents becoming at once broken up into active gonidia, not by successive subdivisions (Pl. 5. fig. 1). Green. Found upon stones or filamentous Confervæ in fresh water, and consisting of elliptical sacs or cells, acuminate above and below, about 1-500″ long and 1-1200″ thick. 2 species.

Bibl. Al. Braun, *Alg. Unicell.*, Leips. 1855, 24.

HYDRODICTYON, Roth.—A genus of Siphonaceæ (Confervoid Algæ), containing one species, *H. utriculatum*, found in fresh-water pools in the midland and southern counties of England. The frond or cœnobium consists of a green open network of filaments attaining a length of 4 to 6″ when full-grown (fig. 338), composed of a vast number of cylindrical tubes (cells) with rounded ends, adherent together at their extremities, the points of junction corresponding to the knots or intersections of the network. The individual cells attain a length of 4‴ or more. The organization of this plant and its development are exceedingly curious; and it has lately been the subject of very careful investigation by Al. Braun and others. The cells forming the links of the net have a remarkably thick cellulose coat when full-grown, which exhibits several layers, especially when treated with sulphuric acid (Pl. 47. fig. 24*l*). Weak sulphuric acid does not affect the outer cuticular layer, while it swells the inner layers, and throws them into waves, especially the innermost; the subsequent addition of iodine colours the inner layers blue, but not the cuticle. Strong sulphuric acid acts differently: it detaches the cuticle at many points, while the inner layers contract, so that the cuticle appears blown up in vesicles; the inner layers gradually soften and dissolve. These last changes are similar to what takes place at the dissolution of the cell when the contents escape; and Cohn states that the membranes give the bluish reaction with iodine alone when thus partially decomposed by natural causes.

Fig. 338.

Hydrodictyon utriculatum. A complete frond or net, about ⅓th of the largest size.

Immediately lining the wall is a mucilaginous layer (Pl. 47. fig. 24*p*), which Braun has shown to consist of several lamellæ:—1. An extremely thin, finely punctate layer, coagulated and detached from the cell-wall by the action of acids; this is the *primordial utricle* of the cell. 2. The *outer mucilaginous layer*, thicker than the primordial utricle, but thinner than the next or third layer. When separated from the first layer, the outer surface appears rough and wavy; and it is connected with the third layer by mucilaginous cords; it contains indistinctly defined colourless granules. 3. The *inner mucilaginous layer*, the thickest of the three, is rough on the outside and waved on the inside from the projection of granules imbedded in it; this is the only green layer, appearing of a homogeneous green colour (like the spiral bands of *Spirogyra*) when the cells are in their prime, besides which it contains innumerable green granules, sometimes in rows, more frequently uniformly scattered. This layer likewise contains starch-corpuscles, such as occur commonly in the green substance of the Confervoids, causing the cell-contents to exhibit a vast number of brilliant points. In imperfect cells the green layer sometimes appears in patches, not completely investing the surface of the outer mucilaginous layer; this is also common in young cells. The fluid in the cavity of the cell is clear and watery.

The reproduction of the fronds of *Hydrodictyon* is effected by the conversion of the contents of the individual cells into complete new sets like the parent, which lets them free by dissolution. The following is a brief history of this remarkable process. The first stage is the solution of the starch-grains; the green layer becomes more opaque; lighter spots appear on the inner part of the mucilaginous layer, excavated in its substance and surrounded by the chlorophyll-globules, which separate from each other, forming dark boundary lines round the light spots. The bright-green then gives place to a browner tinge. The light spots already observed (the centres of the nascent gonidia), exerting an attraction as it were on the chlorophyll-globules, become severally enveloped in a layer of them, and then separate from each other, so as to appear like dark spots with an intervening reticulation of bright lines. The dark spots (gonidia) are now polygonal, mostly six-sided, about the 1-2500″ in diameter. The parent-cell membrane next begins to soften and swell up; the gonidia, thus acquiring more space, become rounded, and soon pre-

sent a slight tremulous oscillatory movement. The cuticle of the parent cell then cracks, allowing the inner softened layers to swell out; the gonidia commence an active trembling and jerking motion, not, however, moving far from one spot; after a time they again come to rest, and become united at certain points of their circumference; the green granules become fused into a homogeneous mass, and the rudiment of the first starch-granule soon appears, while the gonidia grow out into a tubular form, acquire a cellulose membrane, and collectively form a new net, which becomes free by the total solution of the parent cell. These gonidia appear to possess four short cilia; their motion lasts about half an hour; from 7000 to 20,000 occur in one cell; and they are distinguished by Braun as *macrogonidia*. Other gonidia of smaller size and longer shape, which he calls *microgonidia*, are furnished with four long cilia and a red parietal spot. These have a different history. From 30,000 to 100,000 appear in the parent cell, their development presenting the same characters as that of the *macrogonidia* up to the time when the motion begins. Then the *microgonidia*, unlike the net-forming *macrogonidia*, leave their parietal positions with a whirling motion, and move through the entire cavity of the parent cell, until at length the membrane of the latter bulges out in one or more places and bursts, and the microgonidia leave the cavity in a swarm. According to Cohn, they are at first enclosed in a thin mucilaginous pellicle protruded before them, like the swarming spores of PEDIASTRUM. However, they escape, become free, and swim about for a long time, and are supposed to conjugate. At length they come to rest, acquire an outer coat, sink to the bottom, and remain there heaped in green masses, like cells of PROTOCOCCUS, for a long period, forming resting-spores.

The rapidity of the growth of the *Hydrodictyon*-net by the above process is wonderful; the component cells of the net increase, under favourable circumstances, to 600 times their original length in a few weeks. In cultivated specimens, the whole history, from the origin of a net to the production of a new one, passes over in three or four weeks. The original size of the cells is about 1-2500″; in the fully developed condition they are about 1 to 4″ long.

BIBL. Vaucher, *Conferves*, 82, pl. 9; Areschoug, *Linnæa*, xvi. 127, pl. 5 (1842); Hassall, *Algæ*, 225, pl. 58; Braun, *Verjüng.* (*Ray Soc.* 1853); *Alg. Unicell. Sp. Nov.* 1855, 55; Cohn, *Nova Acta*, xxiii. 207, pl. 19; Pringsheim, *Berl. Ber.* 1860; *Qu. M. Jn.* 1862, 54, 104.

HYDROGAS'TRUM, Desv. = BOTRYDIUM.

HYDROI'DA.—The order of Hydroid Polypes (Zoophytes).

The members of this Order usually consist of aggregate hydriform individuals contained in cells or cups, springing from a filiform branched polypidom; propagation gemmiparous and oviparous. Many new names have been used for the component structures, which may well be mentioned here; but we prefer the old ones. One of the forms of non-sexual reproduction is the *zooid*. Zooids differ from organs in that the zooid is an individual organism, which may or may not be capable of individual existence. A community of zooids in union with one another constitutes the *hydrosome*. Zooids are of two kinds: in one, destined for the nutrition of the community, the assemblage is called the *trophosome*; the other gives origin to the generative elements—ova and spermatozoa; and the entire association of these generative zooids is the *gonosome*. The trophosome is composed of the *hydranth* and the *hydrophyton*. The hydranth or polypite contains the digestive sac; the hydrophyton or cœnosarc is the common basis by which the general community is kept together. The *hydrorhiza* is the adherent base. The ultimate zooid, which generates either the ova or the spermatozoa, is the *gonophore*. The *sporosac* is the gonophore without the umbrella. The *gonozoid* is the sexual zooid, whether fixed or detached and fitted for locomotive life; this is also known as a medusiform gonophore, or planoblast. The *gonangium*, or *gonotheca*, is an external receptacle in which the gonophore is formed. (Pascoe.) See ZOOPHYTES.

Hincks divides the Order into 3 sub-orders:—

1. *Athecata* (Tubularina, Johnst.), in which true thecæ are absent. Fam.:

Clavidæ.	Clavatellidæ.
Hydractiniidæ.	Myriothelidæ.
Podocorynidæ.	Eudendriidæ.
Laridæ.	Atractylidæ.
Corynidæ.	Tubulariidæ.
Stauridiidæ.	Pennariidæ.

2. *Thecaphora* (Sertularina, Johnst.), in which the Hydroida are furnished with thecæ. Fam.:

Campanulariidæ.	Coppiniidæ.
Campanulinidæ.	Haleciidæ.
Leptoscyphidæ.	Sertulariidæ.
Lafoëidæ.	Plumulariidæ.
Trichydridæ.	

3. *Gymnochroa* (Hydrina, Johnst.). Polypidom absent; locomotive. Fam. 1. Hydridæ.

The polypidoms of the Hydroid Polypi form interesting microscopic objects. They are very common among sea-weeds, on shells, rocks, &c., the forms being often elegantly branched and feathery (Pl. 41. figs. 4, 11, 15, 16); and the species can be identified from the polypidoms. They may be mounted, after being well-washed in distilled or rain-water, in balsam or glycerine. The animals are very irritable and contractile, and can only be observed after the removal of the bodies to which they are attached to an aquarium or jar containing sea-water.

Bibl. Johnston, *Br. Zooph.* 5; Gosse, *Mar. Zool.* 1, 18; Allman, *Ann. N. H.* 1863, xi. 1; Hincks, *Br. Zooph.* i; and *Ann. N. H.* 1877, xix. 148, 1878, i. 239; 1880, vi. 277 (*Barent's Sea*); Mereschowski, *ibid.* 1878, ii. 251; Korotneff, *ibid.* 1878, ii. 351; Thompson, *ib.* 1879, iii. 97; Pascoe, *Zool. Class.* 1880.

HYDROMETRIDÆ.—A family of Hemipterous (Heteropterous) Insects, the species of which are found skimming the surface of pools or rivers. The under parts of the body and legs are covered with fine hairs, which prevent them from becoming wetted. The eggs of *Hydrometra* are elliptical and elegantly sculptured.

Bibl. Westwood, *Introduction*, ii. 467.

HYDROMORI'NA, Ehr.—A family of Infusoria.

The two genera of which it consists, *Polytoma* and *Spondylomorum*, appear to be Monads, or species of Algæ, undergoing division. See these genera.

Bibl. Ehrenb. *Ber. d. Berl. Akad.* 1848.

HYDROPH'ILUS, Geoff. See Hydroüs.

HYDROPH'ORA, Tode.—A genus of Mucorini (Phycomycetous Fungi). Moulds growing on the dung of animals, distinguished by the indurated persistent peridiole and the conglobated spores. Two species are described as British.

H. stercorea, Tode. Fleecy; filaments simple, very long, fugacious, white; peridioles spherical, yellow, subsequently black. Common on dung after much rain.

H. murina, Fr. Filaments scattered, short, simple, persistent, white; peridioles yellow, subsequently opaque. On rats' dung. (*Mucor fulvus*, Sowerby, pl. 400. fig. 4.)

Bibl. Berkeley, *Hook. Br. Fl.* ii. pt. 2. 331; Fries, *Syst. Mycol.* iii. 314, *Sum. Veg.* 87.

HYDROSE'RA, Wall.—A genus of Diatomaceæ.

Char. Frustules quadrate, areolar, united into a filament, with internal septa; hoop smooth, compressed or triangular in front view, areolar, the constricted angles with a small appendage on one side. Marine.

H. compressa. Valves oblong. East Indies.

H. triquetra (Pl. 51. fig. 40). Valves triangular. East Indies.

H. tricoronata. New Zealand.

Bibl. Wallich, *Qu. M. J.* 1858, vi. 251; Stolterforth, *Jn. Mic. Soc.* 1881, 424.

HYDRO'ÜS, Linn.—A genus of Coleopterous Insects, of the family Hydrophilidæ.

H. piceus is one of the largest aquatic British beetles. We have selected the head to illustrate the structure and arrangement of the trophi, &c. in the Coleoptera (see Insects). The perfect insect is about $1\frac{1}{2}''$ in length. The full-grown larva is about 3'' long; it has no lateral branchiæ, but two filiform branchial appendages at the end of the body.

Bibl. Westwood, *Introduc.*; Duméril, *Consid. gén. s. l. Insectes*; Stephens, *Br. Beetles.*

HYDRU'RUS, Ag.—A genus of Palmellaceæ (Confervoid Algæ), which seems to form a link between these and the Ulvaceæ. The frond consists of a branched, feathery, very gelatinous expansion, the branches set with minute processes or ramelli (Pl. 7. fig. 8*a*); in the gelatinous substance are imbedded minute cells with homogeneous green contents, most closely set in the ramelli, more scattered in the older part of the frond (Pl. 7. fig. 8*b*). *H. Ducluzelii*, Ag., grows to a length of from 1 to 6'', and from 2 to 4''' in diameter, attached to stones in mountain-brooks and rivers; the recent frond is of brownish olive in mass, green when dried. When fresh it has a very offensive smell. Reproduction by active gonidia.

Bibl. Harvey, *Br. Alg.* (1 ed.) 180; Hassall, *Alg.* 302, pl. 77. fig. 3; Kützing,

Tab. Phyc. pl. 34. fig. 3; Rabenhorst, *Fl. Alg.* iii. 49.

HYGROCRO'CIS, Ag.—A supposed genus of filamentous Confervæ; apparently consisting of the flocculent mycelium of Fungi. *H. arsenica* occurs in solutions of arsenious acid.

BIBL. Kützing, *Sp. Alg.* 148; Rabenhorst, *Fl. Alg.* ii. 8 (fig.); Marchand, *Compt. rend.* 1878.

HYME'NIUM.—The term applied to the layer of cellular tissue upon which are seated the *basidia* of the higher FUNGI. The name is also applied to the fructifying stratum in such Ascophorous fungi as *Helvella, Morchella, Peziza*, &c.

HYMENO'MONAS, Stein.—A genus of Flagellate Infusoria.

Char. Free, with a crenate, flexible carapace; flagella two; no eye-spot; lateral yellow-brown pigment bands present.

H. roseola; length 1-850″; freshwater. (Kent, *Inf.* 407.)

HYMENOMYCE'TES.—A tribe of Basidiomycetous Fungi, characterized by the peculiar mode of arrangement of the spores, which are borne in groups of four on the exposed surface of a more or less membranous or sometimes gelatinous layer called the *hymenium*. The fruit, called the receptacle, varies extremely in form. In most of the Tremellini it is an irregular jelly-like or waxy expansion, borne however on a roundish support in *Tremella*; in the Clavati it forms a club-shaped, mostly branched, fleshy or leathery stalk-like body (called the *hymenophore*), which is clothed at its ends by the sporiferous membrane or hymenium, forming a smooth layer. In the Auriculati and Hydnei the receptacle is either an expanded, irregular, crust-like, membranous or leathery mass, or has the form of a club, a funnel, or of a hat or cap, the sporiferous membrane clothing either the upper or under surface as a warty, spiny, or comb-like stratum.

In Polyporei and Agaricini the receptacle is a discoid (often laminated), bell-shaped or dish-formed, fleshy body, more or less coloured and tuberculated on the upper side, frequently borne on a columnar stalk inserted on the under side, while the sporiferous layer, or hymenial structure, presents itself as a conspicuous layer on the under side, consisting of a number of paper-like lamellæ, or vertical tubes, prickles, or pits, closely packed, on the lateral surfaces of which are borne the spores; in many cases, however, the hymenium is perfectly even in the column. The younger stages of development of some Hymenomycetes do not exhibit all these characters, since the receptacle is at first enclosed in a sac-like body arising from the mycelium, so that the external appearance is similar to that of one of the Gasteromycetes (as in very young mushrooms); this sac finally bursts, to allow of the expansion of the receptacle.

The cellular structure of this family is simple, in spite of the varied outward forms; the whole mass, from the filamentous *mycelium* up to the *sporiferous membrane* or *hymenium*, is made up of interwoven branched cellular filaments or hyphæ, of great tenuity. In the Tremellini these filaments are imbedded or dissolved into an amorphous waxy or gelatinous substance; in other cases they form a dry corky structure; but the consistence is generally fleshy. In a few cases among the Agaricini and Polyporei, vesicular or elongated branched hyphæ of considerable size are met with, containing a milky juice (in the gills of *Ag. deliciosus*, &c.). The *spores* are short terminal branches of roundish or elongated cells, called *basidia*, clothing the free surface of the hymenial structure (see BASIDIOSPORES). They may be seen in thin cross sections cutting the laminæ of the Agarics or the tubes of the Polyporei at right angles, requiring a high power for their observation. Four spores are formed on each basidium, from which they fall off when mature. The Agarics exhibit on the hymenium, among the basidia, peculiar projecting vesicles filled with opaque fluid (*pollinaria*, Corda; *cystidia*, Leveillé; *utricles*, Berkeley), which some have called anthers, but which appear to be *paraphyses*—that is, undeveloped or abortive (bare) basidia. The spores are mostly exceedingly minute, of various forms and colours, and consisting of simple cellules. Tulasne has recently shown that the Tremellini produce *spermatia*, as well as *basidiospores*; in *Tremella*, and other genera, they arise from distinct branches of the hymenial filaments; in *Dacrymyces* they are produced in germination from some of the detached basidiospores lying upon the mycelium (see TREMELLINI).

The structure of these Fungi must be investigated in all stages of development, since very great changes of size and form take place at different epochs, simply

from expansion or solution of the cellular textures.

Synopsis of the Families.

AGARICINI. Receptacle like a round or flat cap, oftenborne on a stalk. Hymenium forming vertical plates or folds on the under surface.

POLYPOREI. Receptacle like a round or flat cap, disk, cup, or funnel, sometimes stalked, with a porous (formed of tubes) or reticulated hymenium on the under side.

HYDNEI. Receptacle like a round or flat cap, cup, or funnel, sometimes stalked, with the hymenium on the under side exhibiting awl-shaped processes or tubercles.

AURICULARINI. Receptacle tubular, cup- or funnel-shaped, with the smooth or papillose hymenium on the under surface.

CLAVATI. Receptacles club-shaped, simple or branched like a shrub, with the hymenium covering the tips and sides of them.

TREMELLINI. Receptacle vague, or cup-shaped, often gelatinous at first, hardening by drying up. Hymenium confounded with the structure of the receptacle, on the upper, under, or both surfaces; basidia terminating the branches of hymenial filaments, accompanied sometimes by branches bearing spermatia. The detached spores often lie imbedded in the gelatinous surface of the hymenium, and sometimes produce spermatia there. The above characters refer to the more typical species, as resupinate forms or an expanded hymenophore occur in each of the divisions.

BIBL. Berkeley, *Lindley's Veg. Kingdom*; *Hooker's Br. Flora*, vol. ii. pt. 2; *Ann. N. H.* i. 81, and ix. 1; Leveillé, *Ann. Sc. N.* 2 sér. viii. 321; Fries, *Sum. Veg.* 267; Tulasne, *Ann. Sc. N.* 3 sér. xix. 193.

HYMENOPHYL'LEÆ.—A family of Polypodiaceous Ferns, distinguished by the delicacy of the structure of their leaves and the composition of the sori or fruits. The leaves are of the utmost simplicity of organization, consisting ordinarily of a single layer of cellular tissue, traversed by scalariform tubes constituting the veins. There is no distinction of epidermis and parenchyma, nor are there stomata.

Genera.

Trichomanes. Sporanges sessile around the base of an exserted filiform column, formed by the prolongation of a vein beyond the margin of the leaf, surrounded by a cup-shaped indusium continuous with the leaf (fig. 339).

Hymenophyllum. Sporanges sessile up to the summit of a similarly formed column projecting from the margin of the leaf, subelevated, but not exserted beyond the indusium, which is two-valved (fig. 340).

Fig. 339. Fig. 340.

Trichomanes humile. Hymenophyllum bivalve

Fig. 339. Fragment of a leaf, with sori.
Fig. 340. Ditto.
Magnified 10 diameters.

Loxosoma. Sporanges stalked, inserted up to the summit of a subelevated exserted column arising in a similar way within the margin of the leaf, surrounded by an indusium, somewhat within the margins of the

Fig. 341. Fig. 342.

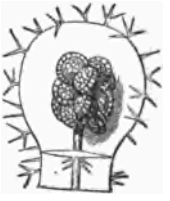


Fig. 343.

Hymenophyllum ciliatum.

Fig. 341. Fragment of a leaf. Magn. 10 diams.
Fig. 342. Sorus with one valve removed Mang. 40 diams.
Fig. 343. Sorus. Magn. 20 diams.

fissures between the teeth of the leaf, with a truncated entire mouth; annulus incomplete.

HYMENOPHYL'LUM, Smith.—Filmy Ferns. The typical genus of Hymenophyllaceous Ferns, remarkable for their delicate structure and often almost moss-like habit. Two dwarf species are natives of Britain, *H. tunbridgense* and *H. Wilsoni*. Numerous tropical species (Hooker, *Syn.* 56).

HYMENOP'TERA.—An order of INSECTS, containing the Bees, &c.

HYPERAM'MINA, Brady.—A tubular and sandy Foraminifer, irregular in extension and growth. (Brady, *Ann. N. H.* 1878, i. 433; *Mic. Jn.* n. s. xix. 13.)

HYPER'ICUM, Linn.—Hinds points out in the leaves of *H. Androsæmum*, the common Tutsan, and *calycinum*, certain dots containing active motile bodies (*M. M. Jn.* xix. 233).

HYPEROMYX'A, Corda. See CHEIROSPORA.

HYPH'EOTHRIX, Kütz.—A genus of OSCILLATORIACEÆ (Confervoid Algæ).

Char. Fil. simple, jointed, coloured, more or less distinctly sheathed, tranquil; fasciculate or densely united into a more or less membranous non-radiate stratum (Pl. 52. fig. 8).

58 European species. In springs, coating water-plants in pools; on rocks, &c.

BIBL. Rabenhorst, *Fl. Alg.* ii. 75.

HYPHOMYCE'TES.—A section of Fungi composed of microscopic plants, growing as moulds over dead or living organic substances. These are now considered to be conidiiferous conditions of Ascomycetous Fungi; but as they are interesting and often very beautiful microscopic objects, the original account is retained here. The vegetative structure or mycelium creeps over or among the structures infested as a collection of delicate, simple or branched, continuous or septate filamentous cells (*flocci*), and produces the spores either on lateral pedicels (from which they soon fall off, becoming intermingled with the mycelium), or in heads at the swollen or ramified extremities of usually erect filaments (figs. 344, 345, 346, and 347). These filamentous pedicels in most cases exhibit a contraction just below the point of origin of the spore, giving them the same appearance as the pedicels of basidiospores. The spores are round (Pl. 26. fig. 15), oval (fig. 347 and Pl. 26. figs. 5, 6), spindle-shaped (FUSISPORIUM), spiral (HELICOSPORIUM), and isolated or connected (fig. 346) in beaded lines (PENICILLIUM, ASPERGILLUS), or grouped in a stellate

Fig. 344. Fig. 345.

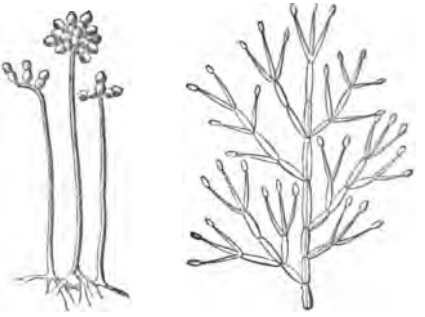
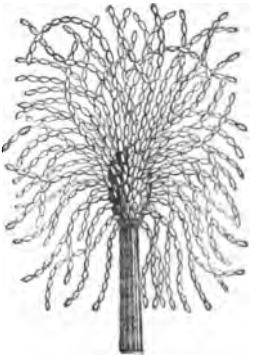


Fig. 344. Cephalothecium roseum. Magn. 200 diams.
Fig. 345. Verticillium nutans. Magn. 200 diams.

Fig. 346.

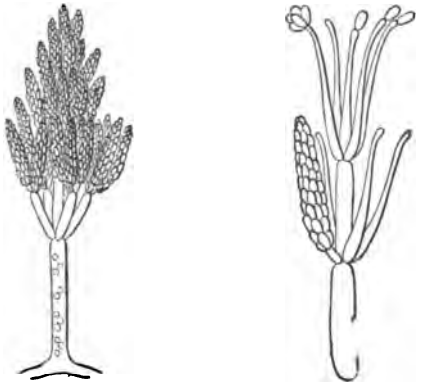


Stysanus Caput-Medusæ.
Magnified 200 diameters.

form. In the Isariacei and Stilbacei the erect pedicels are composed of a number of conjoined filaments; in the other families the pedicels are simple filaments. Some authors include among these plants the Mucorini (PHYCOMYCETES), regarding the vesicular envelope of the spores there as a mere *veil*, not a true cell producing the spores in its interior. This family is of especial interest from containing so many moulds and mildews, and various parasitical Fungi to which the diseases of plants, and in some cases of animals, have been attributed. Further particulars respecting

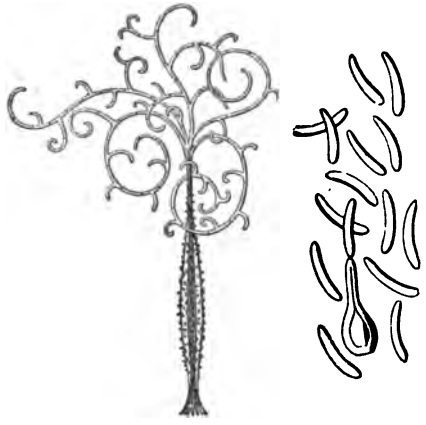
these will be found under the Families, also PARASITIC FUNGI.

Fig. 347. Fig. 348.



Clonostachys Araucaria.
Fig. 347. Magn. 200 diams.
Fig. 348. A fertile branch. Magn. 400 diams.

Fig. 349. Fig. 350.



Ceratocladium microspermum.
Fig. 349. Magnified 200 diams.
Fig. 350. Spores, magnified 400 diams.

Synopsis of the Families.

ISARIACEI. Receptacle clavately branched, or assuming Hymenomycetous forms, composed of filaments closely attached in their whole length; spores simple, attached to simple pedicels arising in all parts (fig. 349).

STILBACEI. Receptacle wart-like or clavate above, stalked below, composed of filaments closely packed, coherent, terminating singly in free subgelatinous spores.

DEMATIEI. Mycelium filamentous, spores compound or simple, arising from the apices of erect, solid, corticate, subopaque filaments (fig. 346).

MUCEDINES. Mycelium filamentous, spores solitary, or crowded on articulated or branched tubular and pellucid filaments (figs. 344, 345), soon separating and mingling with the mycelium, or adherent in chained rows.

SEPEDONIEI. Mycelium filamentous, spores usually found heaped together resting on the mycelium, and apparently springing out of it directly. The spores are the principal element in this Order, which approaches Coniomycetes.

HYP'NEA, Lamouroux.—A genus of Rhodymeniaceæ (Florideous Algæ), the only British species of which, *H. purpurascens*, is a common purplish pink feathered or shrubby sea-weed, the lobes being cylindrical, filiform, and cartilaginous, growing from 2″ to 6″ in height, with the filaments about 1‴ in diam. On stones, rocks &c. between tide-marks. The fructification consists of *coccidia*, tubercles immersed in the ramuli, each containing a mass of small spores; and *tetraspores*, immersed in the lesser branches, of separate plants.

BIBL. Harvey, *Mar. Alg.* 130, pl. 16 D; *Phyc. Brit.* pl. 116; *Eng. Bot.* pl. 1243.

HYPNOI'DEÆ.—A family of Pleurocarpous Mosses of large extent. Leaves with the cells prosenchymatous, dense or lax, smooth or papillose. Alar cells at the bases of the leaves diverse: 1, square, flattish or ventricosely impressed, pellucid or yellowish, or fuscescent; 2, few, vesicular, placed at the very base, of a delicate yellow or hyaline; 3, obsolete, scarcely any, placed at the very base, fugacious, hyaline, vesicular; 4, many, square, in papillose leaves, but mostly not very conspicuous. Leaves 0-5-nerved. Nerves binate, diverse: 1, divergent from the base, distinct, very callous at the back of the leaf and prominent in the form of a spine from the dorsal surface; 2, flattened down, scarcely callously prominent; 3, in leaves where the alar cells are vesiculiform, the nerves obsolete, indicated by a pair of very short striæ, mostly inconspicuous.

British Genera.

a. *Internal peristome without interposed cilia.*

Neckera. Calyptra dimidiate. Peristome

double, single, or absent, the internal or the external or both being occasionally obsolete. External: sixteen equidistant or more or less geminate teeth, lanceolate, trabeculate, with a longitudinal line, composed of a double layer, arising below the orifice, sometimes split into several irregular arms. Internal: similar to the above, or capillary, placed on a more or less exserted membrane, conjoined by transverse appendages, very often wholly or partly cancellate. No interposed cilia.

Plotrichum. Calyptra mitriform. Peristome, &c. as in NECKERA.

b. *Internal peristome with interposed cilia.*

Hookeria. Calyptra mitriform. Peristome double; external teeth lanceolate-subulate, with a more or less broad longitudinal median line, trabeculate; internal on a more or less deep keeled membrane, subulate, scarcely ciliiform; rudimentary cilia interposed, hardly conspicuous, or, more rarely, perfect.

Hypnum. Calyptra dimidiate. Peristome double. External teeth sixteen, lanceolate, trabeculate, with a more or less broad longitudinal line, more rarely a fissure, with more or less crest-like prominent trabeculæ within. Internal teeth on a grooved reticulated projecting membrane, lanceolate, articulated, grooved, solid or perforated in the middle, or altogether gaping and separating. Cilia one to four, interposed, very often rudimentary.

HYP'NUM, Dill.—A large genus of Hypnoideæ (Pleurocarpous Mosses), here including the species referred by modern writers to *Isothecium*, *Climacium*, *Leskea*, &c. Many of them are extremely common in all woods, growing on trunks of trees, banks, &c.; others grow in water or in bogs, &c. The distinctions of the species are taken in great part from the forms &c. of the leaves, which require the use of a microscope for their accurate determination.

BIBL. Wilson, *Bryol. Br.* 335; Hooker, *Br. Flora*, vol. ii. pt. 1; Müller, *Syn. Muscorum.*

HYPO'CREA, Fr.—A genus of Sphæriacei (Ascomycetous Fungi), with a horizontal, sessile, or indistinct fleshy, mostly coloured stroma, filiform asci, and simple spores. The species of this genus, like those of *Hypoxylon*, as given by Fries, are partly referred to *Sphæria* by other authors; the distinctions will be best explained by taking all these genera under SPHÆRIA.

HYPO'DERAS, Frauenfeld.—A genus of Acarea (Acarina). Numerous species, occurring beneath the skin of birds, often forming little cysts.—Giebel, *Verh. zool.-bot. Gesell. Wien*, xiv. 385; Murray, *Ec. Ent.* 228 (figs.); Robertson, *Jn. Mic. Soc.* vi. 201.

HYPODER'RIS, R. Brown.—A genus

Fig. 351.

Hypoderris Brownii.
Sorus with fringed indusium.
Magnified 25 diameters.

of Dicksonieæ (Polypodiaceous Ferns), with very prettily fringed indusia. Exotic. (Hooker, *Syn.* 46.)

HYPOGÆ'I.—A family of Gasteromycetous Fungi, characterized by their resemblance to the Truffles (Ascomycetes) in

Fig. 352.

Hydnangium candidum.
Basidiospores upon the hymenium.
Magnified 400 diameters.

Fig. 353.

Hysterangium clathroides.
Section of hymenium with oval basidiospores.
Magnified 400 diameters.

growing underground, and by their fleshy indehiscent receptacle, which is excavated into sinuous cavities lined with *basidiospores*, which are sometimes smooth and sometimes tuberculated (figs. 352, 353).

See Pl. 27. fig. 8.

Bibl. Tulasne, L. R. & C., *Fungi Hypogæi*, Paris, 1851; *Ann. Sc. N.* 3 sér. xv. 267, and *Ann. N. H.* 1851, vol. viii. 19; *Berk. Outl.* 292.

HYPOLE'PIS, Bernh.—A genus of Pterideæ (Polypodiaceous Ferns), remarkable as varying in the condition of the indusium so as to become undistinguishable from Polypodium. Seven species, tropical. (Hooker, *Syn.* 129.)

HYPOMY'CES, Tul.—A genus of Pyrenomycetes (Ascomycetous Fungi), proposed by Tulasne to include the coloured species which are parasitic and spring from a thick floccose mycelium. Their conidia are often extremely curious, and have been referred to *Sepedonium*, *Asterophora*, *Dactylium*, &c. The species were formerly included in *Hypocrea*.

Bibl. De Bary, *Bot. Zeit.* 1859, 385, 393; Tul. *Carp.* iii. 38.

HYPOPTERYGIA'CEÆ.—A family of Pleurocarpous Mosses with a peculiar arrangement of the leaves, which are placed in two opposite straight rows united on the upper side of the stem, with a third median row of smaller stipuliform leaves on the

Fig. 354.

Fig. 355.

Hypopterygium.

Fig. 354. Natural size.

Fig. 355. A leafy branch. Magnified 5 diams.

under side, bearing a resemblance to the intermediate leaves in *Selaginella* (figs. 354, 355). The cells of the leaves are parenchymatous and equal in all parts. The genera are all exotic, viz. *Hypopterygium*, *Cyathophorum*, and *Helicophyllum*.

HY'POPUS, Dug.—A formerly supposed genus of Acarina, and family Acarea.

Char. Body ellipsoidal, coriaceous; palpi absent; labium oblong, prolonged in the form of a rostrum, and furnished with two long anterior rigid setæ; the posterior pairs of legs but little developed. The forms are numerous, and are found as parasites upon both animals and plants, as *Arvicola* (the field-mouse), *Bombus* (the humble-bee), *Musca* (fly), some Myriapoda, and even upon other Acarina; also upon ferns, &c. Dujardin supposed that they were young forms of *Gamasus*; Claparède that they were the males of certain *Acarea*; while Mégnin decides that they are the nymphs of *Acari* (*Tyroglyphus*, &c.). They have no mouth nor digestive organs; but are furnished with posterior ventral suckers.

Pl. 6. fig. 15 represents a *Hypopus muscarum*, which we found upon a house-fly (*Musca domestica*).

Bibl. Dugès, *Ann. Sc. Nat.* 2 sér. i. 20, ii. 37; Gervais, *Walckenaer's Arachn.* iii. 265; Dujardin, *Ann. Sc. Nat.* 3 sér. xii. 243 & 259; Claparède, *Zeitschr. wiss. Zool.* 1868, xviii. 445; Murray, *Ec. Ent.* 231; Mégnin, *Paras.* 146.

HYPOTHE'CIUM.—The term applied to the layer of cellular tissue, on which are attached the thecæ or spore-sacs of the fruits of the Lichens.

HYPOX'YLON, Fries. — A genus of Sphæriacei (Ascomycetous Fungi), distinguished by a sessile stroma, separate and distinct from the matrix (see Sphæria). The *Hypoxyla* of Bulliard with an erect stroma belong to Xylaria.

HYSTE'RIUM, Tode.—A genus of Phacidiacei (Ascomycetous Fungi), distinguished by the elliptical or elongated peri-

Fig. 356.

Fig. 357.

Hysterium degenerans.

Fig. 356. Natural size.

Fig. 357. Perithecium. Magnified 10 diameters.

thecia (figs. 356, 357), bursting by a simple longitudinal slit. The species are numerous, growing upon (usually dead) bark,

stems and leaves of various plants. *H. rugosum* has been placed by some authors among Lichens (as *Odegrapha macularis, epiphega*, Eng. Bot.). It is common on smooth *living* branches of oak and beech. *H. pulicare, H. Rubi, H. Pini*, and *H. culmigenum*, the grass-*Hysterium* and *H. foliicolium*, growing on leaves of hawthorn, ivy, or oak, are common. The species with septate spores (fig. 359) form the genus *Hysterographium*, Corda.

Fig. 358. Fig. 359.

Fig. 358. Hysterium foliicolium β Hederæ. An ascus containing eight spores, magnified 100 diameters; with loose spores, magnified 200 diameters.

Fig. 359. Hysterium elongatum. Spores. Magnified 400 diameters.

BIBL. Berk. *Hook. Br. Fl.* vol. ii. pt. 2. 293; *Ann. N. H.* 1851, vii. 185; Fries, *Sum. Veget.* 368; Greville, *Sc. Crypt. Fl.* pls. 24, 26, 72, 87, 88, 129 & 167.

I.

ICHNEUMON'IDÆ.—A family of Hymenopterous Insects. The ovipositor is an interesting microscopic object. (Westwood, *Insects*, ii. 140.)

ICHTHYDI'NA, Ehr.—A family of Rotatoria.

Char. No carapace; rotatory organ single, continuous, not lobed nor divided at the margin.

The rotatory organ is in the form of a circle in *Ptygura* and *Glenophora*; in *Ichthydium* and *Chætonotus* it is long, band-like, and placed upon the ventral surface.

The family is thus divided:—

Eyes absent,
  No hairs present,
    Tail-like foot simple and truncate... *Ptygura.*
    " forked ..... *Ichthydium.*
  Having bristly hairs,
    Tail simple, truncate..... *Dasydytes.*
    Tail forked ..... *Chætonotus.*
Eye single, frontal..... *Sacculus.*
Eyes two, frontal ..... *Glenophora.*

Dujardin places *Ichthydium* and *Chætonotus* among the Infusoria; and *Ptygura* among his Melicertina.

BIBL. Ehrenberg, *Infus.* 386; Dujardin, *Inf.*; Schultze, *Müll. Archiv*, 1853, 241.

ICHTHYD'IUM, Ehr.—A doubtful genus of Rotatoria, of the family Ichthydina.

Char. Eyes absent; body without dorsal hairs; pediform tail forked; locomotion effected by cilia placed upon the ventral surface.

Dujardin places this genus among his symmetrical Infusoria.

I. podura (Pl. 31. fig. 23). Body linear-oblong, often slightly constricted near the anterior turgid and sometimes trilobate end; foot short; freshwater; length 1-140".

BIBL. Ehrenberg, *Infus.* p. 388.

ICHTHYOPHTHI'RIUS, Fouquet.—A genus of Holotrichous Infusoria.

Char. Subglobose; with an anterior suctorial disk, including converging setæ. Somewhat like *Pantotrichum*.

I. multifiliis (Pl. 53. fig. 19). Parasitic on the trout, the loach, &c.; forming milky spots on the fins, gills &c.; length 1-150". (Kent, *Inf.* 530.)

IDMO'NEA, Lamx.—A genus of Infundibulate Cyclostomatous Polyzoa, of the family Tubuliporidæ.

Distinguished by the erect dichotomously divided zoary; and the tubular cells, on one side only, in transverse rows, divided into two sets by a median longitudinal line.

I. atlantica. Branches roundish, tapering to a point; cells four in each row, the innermost tubes considerably protruded. Height 4-10". On zoophytes.

BIBL. Johnston, *Br. Zooph.* 278; Busk, *Br. Mus. Cat., Foss. Pol. Crag* (*Pal. Soc.*); Hincks, *Polyz.* 450.

I'DUNA, Cl. & Lachm.—A genus of Infusoria, fam. Ervilina.

Char. Those of Ervilina with a carapace, the valves quite separate.

I. sulcata. Right valve with four raised longitudinal ribs; left valve plane and smooth. Northern sea. Length 1-180".

BIBL. Clap. and Lachm. *Infus.* p. 283.

I'DYA, Philippi = *Canthocamptus*, pt., Baird. *I. furcata* = *C. f.* (Brady, *Copep., Ray Soc.* ii. 171).

ILIOPSYL'LUS, Br. & Rob.—A genus of Copepodous Entomostraca.

I. coriaceus, in sea-mud. (Brady, *Copep.* ii. 143.)

ILLICIUM. See WINTEREÆ.

ILLOSPORIUM, Mart.—A genus of Stilbacei (Hyphomycetous Fungi), mostly rose-red gelatinous bodies growing upon

Lichens, described as consisting of irregular spores, at first involved in a globule of mucus, and afterwards glued together in simple mealy patches (these plants seem very obscure). Four species are described as British:

I. roseum, Fr. (Grev. *Sc. Crypt. Fl.* pl. 51).

I. carneum, Fr. (Corda, *Ic. Fung.* iii. fig. 1).

I. corallinum, Rob. (Desmaz. *Exsicc.* no. 1551).

I. coccineum, Fr. (Cord. *l. c.* fig. 3).

BIBL. *Op. cit.* and Berk. *Br. Flora*, ii. pt. 2, 328; *Ann. N. H.* 1850, v. 466; Fries, *Sum. Veg.* 482; *Syst. Myc.* iii. 259.

ILLUMINATION.—This has been specially alluded to in the Introduction (p. xxviii), and in the articles ANGULAR APERTURE, DIATOMACEÆ, POLARIZATION, and TEST-OBJECTS. But several papers have been published in recent years, describing new and ingenious methods of illuminating the finer and more difficult objects, to which we can only refer.

BIBL. Higgins, *Qu. Mic. Jn.* x. 150; Abbe, *M. M. Jn.* xiii. 77; Smith, *ib.* 88; Wenham, *ib.* 156, & *Engl. Mechanic*, 1877, 279; Whittell, *ib.* xiv. 109; Bramhall, *ib.* xvi. 102; Osborne, *ib.* xvii. 179; Moorehouse, *ib.* xviii. 29; Woodward, *ib.* xviii. 61; Edmunds, *ib.* xviii. 78; Schulze, *Jn. Mic. Soc.* 1878, 45.

ILYOBA'TES, G. O. Sars (=KRITHE, B., C., & R.).—A genus of Ostracoda (Entomostraca), of the family Cytheridæ. Lower antennæ 4-, upper 5-jointed, with the last three joints short and stout; first two pairs of feet three-jointed; eyes wanting.

3 species. *Recent* in Norway, Britain, Bay of Biscay. *Fossil*, Tertiary and Post-tertiary, England.

BIBL. Brady, Crossky & Robertson, *Post-Tertiary Entom.* 1874, 184.

ILYOCRYPTUS, G. O. Sars.—A genus of Macrotrichidæ (Entomostraca).

1 species.

Britain, Russia, Germany, Sweden.

BIBL. Norman and Brady, *Mon. Brit. Entom., Nat. H. Tr. North.* vol. i. 17.

IMPERFORA'TA.—A division of the Foraminifera, characterized by the absence of pseudopodial pores or tubules in the shell, which is either membranous (family Gromidæ), porcellaneous (fam. Miliolidæ), or arenaceous (fam. Lituolidæ). (See FORAMINIFERA.)

BIBL. Carpenter, *Introd. For.* 62.

INAC'TIS, Kütz.—A genus of Oscillatoriaceæ (Confervoid Algæ).

Char. Filaments sheathed, indistinctly jointed, parallel, sometimes dichotomous, densely aggregated, and forming a pulvinate hemispherical frond, springing from a substratum of *Protococcus*-like cells.

In pools, on other Algæ; on rocks, &c.

3 species, with several varieties.

BIBL. Kützing, *Phyc.* 77; Rabenhorst, *Fl. Alg.* ii. 159.

INDIA-RUBBER, or CAOUTCHOUC.—This substance occurs naturally in globules suspended in the milky juices of many plants, especially of the Orders Euphorbiaceæ, Urticaceæ, and Apocynaceæ; the form of the globules is varied. In Pl. 48. fig. 23 is represented part of a milk-vessel of *Euphorbia antiquorum* with fine caoutchouc globules. When such milky juices are evaporated, the globules become blended into a uniform elastic mass, the India-rubber.

Solution of caoutchouc is sometimes used as a cement for closing glass cells; but its chief importance in this respect depends on its forming a constituent of *marine* glue (see CEMENTS).

INDICATOR, QUEKETT'S.—Is a small steel moveable hand placed just above the diaphragm of the eye-piece, so as to point to nearly the centre of the field.

INDIGO.—This well-known vegetable substance is chiefly obtained from plants of the genera *Indigofera* and *Isatis*, and *Polygonum tinctorium*, but may be found in many others.

It has also been found in human urine, of which it is probably a normal constituent. Its best marked character is that of subliming in flattened prisms and plates (Pl. 10. fig. 14).

Indigo is sometimes used as a colouring-matter for injections, and is also very useful for colouring the internal cavities of Infusoria which swallow the granules; also for rendering visible ciliary motion (see INTRODUCTION, p. xxxvi), &c. The simplest mode of employing it is to rub it from a water-colour cake of indigo very gently with a little water. The Infusoria require to be left in the coloured mixture some time; and it is well to remove them into clean water for examination.

Indigo-carmine forms the basis of some excellent staining solutions.

BIBL. See CHEMISTRY.

INFLAMMATION.—The phenomena of

inflammation are best studied in one of the lower animals, as in the web of the frog's foot, the mesentery of the frog, the tail of the tadpole, or of the larva of the water-newt (*Triton*), the process being excited by the application of a hot needle, a solution of common salt, ammonia, dilute spirit, or volatile oil.

The principal phenomena are as follows:—

1. *Changes in the blood-vessels and circulation.*

2. *Exudation of liquor sanguinis and migration of white blood-corpuscles; and*

3. *Alterations in the nutrition of the inflamed tissue.*

1. The first effect of irritation of the mesentery (mere exposure to the air being sufficient for the purpose) is to cause dilatation of the arteries, and subsequently that of the veins. The dilatation of the arteries commences at once, and is not preceded by contraction. It gradually increases for about twelve hours, and is associated at the commencement of the process with an acceleration in the flow of blood; this, however, is soon followed by a considerable retardation. These alterations in the rapidity of the blood-flow, however, cannot be owing to the increase in the calibre of the vessels, which remain throughout dilated.

The retardation of the circulation usually commences somewhat suddenly, and is first observable in the veins. The rapidity of the current varies, however, in different vessels; in some (both arteries and veins) it may be more rapid, in others very slow, and either oscillating to and fro, or even completely stagnant. These differences may occur in contiguous vessels. The capillaries and small arteries often present at the same time numerous irregular bulgings and contractions.

As the circulation becomes slower, the white blood-corpuscles (leucocytes) accumulate in the veins. Their natural tendency to adhere to the sides of the vessels is increased, so that they may nearly fill the tube. At the same time they exhibit active movements, by means of which they penetrate the walls of the vessels and pass into the surrounding tissues. The absolute number of white blood-corpuscles may also be increased owing to the irritation of the lymphatic structures in the vicinity of the inflamed tissue.

The red corpuscles also accumulate in the capillaries. They adhere to one another and to the sides of the vessels, and become so closely packed that their outlines can scarcely be distinguished. Increased adhesiveness of the red corpuscles has long been regarded as characteristic of inflammatory blood, by virtue of which they exhibit a greater tendency to cohere in rolls than in health.

The diminution in the rapidity of the circulation, and the accumulation of the blood-corpuscles in the vessels, is followed by the complete stagnation of the current, constituting the condition long known as *inflammatory stasis*.

2. Another constituent of the inflammatory process consists in the exudation of liquor sanguinis and the migration of the colourless blood-corpuscles.

The migration of the colourless blood-corpuscles (leucocytes) through the walls of the blood-vessels was first described by Addison in 1842. This observer stated that in inflammation, these corpuscles adhered to the walls of the vessels and passed through them into the surrounding tissues. In 1846 Waller more fully described the same phenomenon. Both these observers concluded that the escaped corpuscles became pus-corpuscles. Cohnheim in 1867 brought the subject forward; and to him we owe most of our present knowledge respecting it.

The migration may be observed in the mesentery of a frog which has been previously paralyzed by the subcutaneous injection of curare.

The colourless blood-corpuscles which accumulate in large numbers, especially in the veins, remain almost stationary against the walls of the vessel, the blood-current passing by them, although with much diminished velocity. Those immediately adjacent to the wall gradually sink into it, and pass through it, between the epithelial cells, into the surrounding tissue. In doing so they may be observed in the various stages of their passage. At first small button-shaped elevations are seen springing from the outer wall of the vessel. These gradually increase until they assume the form of pear-shaped bodies, which still adhere by their small ends to the vascular wall. Ultimately the small pedicle of protoplasm by which they are attached gives way and the passage is complete, the corpuscle remaining free outside the vessel.

The corpuscles having escaped from the vessels into the surrounding tissues, continue

to exhibit active movements. They may multiply by division, and thus rapidly increase in number: this will be again referred to when speaking of pus.

Not only is there a migration of colourless blood-corpuscles in inflammation, but the red corpuscles also pass through the walls of the blood-vessels, though in less considerable numbers; and their transit is mainly through the walls of the capillaries. This passage of the red corpuscles takes place in simple mechanical congestion; and it may be observed in the web of a frog in which congestion has been artificially induced by ligature of the femoral vein.

Associated with the passage of the blood-corpuscles through the walls of the vessels, is an exudation of the liquor sanguinis. The exuded liquor sanguinis, which constitutes the well-known inflammatory effusion, differs from the liquid which transudes as the result of simple mechanical congestion, inasmuch as it usually contains a larger proportion of albumen and fibrine, a proportion which increases with the intensity of the inflammation. It also contains an excess of phosphates and carbonates.

The most characteristic feature of inflammatory effusion is the large number of cell-structures which it contains. These are in no case generated spontaneously in the effused liquid. Most of them are migrated blood-corpuscles; and others are derived from the proliferating elements of the original tissue. The quantity and nature of the effusion will thus vary with the particular tissue inflamed, and with the severity of the inflammatory process. In non-vascular tissues, as cartilage and the cornea, exudation can only occur to a small extent from the neighbouring vessels, and hence the effusion is small in quantity. In dense organs, as the liver and kidney, owing to the compactness of the structure, a large amount of effusion is impossible; and what there is, is so intermingled with the structural elements of the organ, that it does not appear as an independent material. In the kidney, it escapes into the urinary tubes and so appears in the urine. The effusion is most abundant, and constitutes an important visible constituent of the inflammatory process, in inflammation of those organs which possess a lax structure and in which the vessels are but little supported, as the lungs, and in tissues which present a free surface, as mucous and serous membranes.

3. The remaining constituent of the inflammatory process consists of an alteration in the nutrition of the inflamed tissue. The nutritive changes, although they may differ according to the structure of the part, are all characterized by an increase in the nutritive activity of the cellular elements. The nature of these nutritive changes has for the most part been ascertained by the investigation of tissues in the lower animals, in which inflammation has been artificially induced. In man the study of the primary tissues is difficult, owing to the fact that the process can rarely be observed in its earlier stages. The alteration in nutrition, as already stated, is characterized by an exaltation of the nutritive functions of the cellular elements of the tissues involved in the inflammatory process. This is evidenced by an increase in the activity of those elements which normally exhibit active movements, as the amœboid cells of connective tissue and of the cornea. Cells which, under normal circumstances, undergo no alterations in form, and exhibit no active movements, become active, sending out processes and undergoing various alterations in shape. This increase in the activity, and variation in the form of the cells is in most cases followed by enlargement and division of their nuclei and protoplasm, and thus by the formation of new cells.

The increased activity of the cellular elements varies considerably in different tissues, and even in the elements of the same tissue. Some cells exhibit active movements, and form new cells, much more readily than others. Those tissues, for example, which naturally maintain themselves by the multiplication of their elements, as the epithelial tissues, become active very readily in inflammation, slight degrees of irritation being sufficient to cause in them rapid cell-proliferation. This is seen in inflammation of mucous membranes, and of the epidermis. In tissues, on the other hand, whose elements normally exhibit no tendency to multiplication, as common connective tissue, cartilage, and bone, active changes are much less readily induced; the cells are much more stable, and multiply with far less facility. Lastly, in the higher tissues the stability of the elements reaches its maximum, and in nerve-cells no increase of activity can be induced. Different cells in the same tissue exhibit also different degrees of stability. In common connective tissue and the cornea, for example, the amœboid

cells are the least stable, and are the first to multiply. Possibly the age of the cells may influence their tendency to become active, the newer being less stable than the older elements. In all cases, however, the rapidity and extent of the proliferation are in direct proportion to the intensity of the inflammation. The earliest nutritive change is thus one of cell-proliferation; the subsequent ones are characterized either by impairment of nutrition and the degeneration and death of the newly formed elements, or by the development of these into a permanent tissue. The more intense the inflammation the greater is the rapidity of the cell-proliferation, the more abortive are the young cells, and the less is their tendency to form a permanent tissue. In connective tissues these changes in the cells are necessarily accompanied by changes in the intercellular substance. The latter are for the most part characterized by softening. In common connective tissue the fibres in the first place become succulent and less distinct, and ultimately they are completely destroyed; in cartilage the matrix softens and liquefies; in bone the lime-salts are removed, the lamellæ disappear, and the osseous structure becomes converted into medullary tissue. Hence the destructive effect of the inflammatory process.

Those retrograde cells which undergo fatty degeneration, are known as exudation corpuscles (Pl. 38. fig. 7).

The inflammatory exudation, consisting of emigrant cells, which often undergo fissiparous multiplication, of the proper cells of the inflamed tissue, which undergo increase of size and numbers, and of the fibrinated liquor sanguinis, may undergo *resolution, organization, suppuration*, and *organization after suppuration*:—

Resolution, by distribution of the emigrant cells over a wider area, and their return into the lymphatics, and by a process of fatty degeneration of the cellular elements.

Organization, by the timely development of blood-vessels, and the conversion of the exudation into fibrillar connective tissue. The cells which are not devoted to the formation of blood-vessels, grow spindle-shaped, and are so closely packed that they give rise to a new variety of tissue. It forms cylindrical or slightly flattened bundles which interlace.

Suppuration. See Pus.

Bibl. Works on Medicine; Lebert, *Phys. Pathol.*; Wedl, *Path. Hist.*; Förster, *Path. An.*; Gluge, *Atlas Path. An.*; Lister, *Inft., Phil. Trans.* 1859; Cohnheim, *Virchow's Archiv*, xl. 1, and *Entzündung*, 1873; Stricker, *Qu. M. J.* x. 242: Cornil and Ranvier, *Hist. Path.*; *Inflam., Holme's Syst. Surg.* i. *and Append.*; Virchow, *Cell. Path.*; Rindfleisch, *Path. Gewebel.* 1878; Green, *Path.*

INFUNDIBULA'TA.—An order of Polyzoa. (See Polyzoa.)

INFUSO'RIA.—A class of Protozoa.

Char. Microscopic animals not furnished with either vessels or nerves, but exhibiting internal spherical cavities; motion effected by means of cilia, or variable processes formed of the substance of the body, true legs being absent. (Body composed of proteine compounds; soluble in solution of potash.)

Every one who has examined with a microscope a drop of water containing animal or vegetable matter which has been set aside for a time, or a drop from any pool or ditch, must have observed numerous minute beings in active motion, resembling some of those figured in Pls. 30, 31, & 32; these are Infusoria, or the animalcules of infusions.

Perhaps no question has been more discussed than that of the structure of the Infusoria. Ehrenberg regarded them as being highly organized, and furnished with distinct organs like the higher animals; whilst some more recent authors consider them as representing simply a nucleated cell. Unfortunately the facts are not accordant with either of these views, and the question must be considered as still *sub judice*.

The more or less flexible body of the Infusoria is usually covered with vibratile cilia, which appear to spring from a cuticle. They are sometimes collected in a circle around an opening or mouth, which leads to a gullet terminating in the soft sarcode of the centre of the body. This central portion of the granular and otherwise structureless sarcode is surrounded by a denser or cortical layer, which underlies also the cuticle. In the cortical layer are the vacuoles and the nucleus and nucleolus; whilst in the inner mass are the spaces which are produced by the ingestion of food and water, and which have been termed stomachs, whence the former name, the *Polygastrica*. There is a rotatory movement of the soft sarcode surrounding these digestive spaces, which causes them to change their positions before they disappear. The animalcule moves some of its cilia voluntarily; others appear to be in constant movement, and they are

the principal locomotive and ingestive organs. The diversity of shape and structure is very great amongst the Infusoria; and it is therefore necessary to consider the details of the different parts composing them separately and in order.

Integument.—The bodies of Infusoria consist of sarcode, of which the outer layer possesses usually considerably more consistence than the internal portion. Cohn demonstrated the presence of this pellicular layer in *Paramecium* by the addition of alcohol, and noticed that the softer tissues remained united to it by a process in one place only, where the short gullet, which is also lined by a continuation of the external tissue, dips down and merges into them. This hard transparent pellicle or cuticle is elastic, but its contractility is doubted; and it often becomes visible when the Infusoria are kept in a small quantity of water upon a slide, the globules of sarcode which escape from rupture of the body carrying it before them. It is frequently beautifully marked with minute depressions (Pl. 32. fig. 1), regularly arranged, and from each of which a cilium arises. This cuticle must be regarded as a secretion from the outer or cortical layer of the sarcode; and it is by no means improbable that Leydig's assertion that it arises from a layer of extremely delicate and small cells will turn out to be correct.

Many Infusoria have a carapace or lorica, which is in some soft and in others very hard; the relation of the hard carapace to the pellicular layer is not, however, very distinctly known. The carapace is often not adherent to the body of the Infusoria, but forms a kind of sheath for the protection of the soft tissues; or it may form one or two valves which are more or less completely soldered together. These tests are thicker and less elastic than the cuticle; and the peduncles which support many species of Infusoria, and which in some instances are hollow and contain a contractile sarcode by which they are secreted, belong to the same kind of structures. Beneath the pellicular layer, the substance of the body frequently appears thicker, although no distinct layer can be separated; and it is doubtful whether the markings are situated in the outer coat, or whether the latter derives them from being moulded upon the inner coat, to which they may properly belong.

This cortical layer (parenchyma of Claparède and Lachmann), as it is called, is firmer than the central and more diffluent sarcode, with which it is continuous internally. It is almost homogeneous; but an indefinite and irregular reticulation and fibrillation may be observed in many species, and especially in the Vorticellæ, close to the insertion of the peduncle, with whose contractile fibre it is continuous. The fibrils and the so-called muscles of the peduncle are composed of sarcode, which has no definite structure, and which is here and there faintly granular; but they possess the power of contracting more or less. Besides these, there are the minute granule-looking cells immediately under the pellicle (which have already been noticed), the contractile vesicles or spaces with their ramifications, the nucleus and nucleolus, and sometimes chlorophyll-granules. When present, the brightly coloured pigment-spots, the so-called eyes, appear to be produced in this layer; and the whole of the cilia are continuations of it. Wright has observed amœboid movements in this layer. The portion of the body which is surrounded by and more or less continuous with the cortical layer, and which is subject to rotation, is softer and often contains granules and corpuscles resembling fat-cells. The mouth and gullet open into this central sarcode; and the anus, when it exists, leads from it. Numerous digestive vacuoles are observed in this watery sarcode, which often presents the appearance of being faintly divided by films and fibres of less diffluent protoplasm.

The existence of the outermost coat or pellicle is demonstrated by the phenomenon of *ecdysis*, which occurs in certain species. But this does not exist in all cases; for in some Infusoria the body adheres readily to the glass of the slide on which it is viewed under the microscope, and is torn up into fragments in the endeavour to free itself.

The cortical layer of some species produces trichocysts or thread-cells. These are fusiform, colourless, and transparent bodies, 1-2500″ in length, arranged on the outside of the body and perpendicularly to it. Irritation of the surface causes them to be transformed into long filaments; and they are more or less like the thread-cells of the Polypes; but they are developed within the cortical layer, and not as cells on its surface.

Minute amylaceous crystalloids, coloured blue with iodine, have been observed in *Strombidium*.

Locomotive organs.—No distinct muscular

structure can be detected in the Infusoria, but a contractile power is possessed by the general substance of the body. In *Vorticella* (Pl. 32. figs. 21 *a* & 26) and some others, the contractile substance is prolonged through the hollow pedicle, thus forming a spurious muscular band.

The other directly or indirectly locomotive organs are thus distinguished. 1, cilia: these are the most common, and form the fine, short, very transparent, hair-like filaments projecting from the surface. In some they entirely cover the surface, whilst in others they are arranged in one or more rows round the mouth or upon the ventral surface, &c., as described under the genera. During life they are seen actively vibrating; and in some their motion appears constant; whilst in others it is interrupted at intervals, apparently under the influence of a will. They are most distinctly seen when the Infusoria are dried (see Cilia). 2, flagelliform filaments (Pl. 31. fig. 59), which are long anterior cilia, the ends alone being vibratory and movable in all directions; there are usually one or two only. 3, retracting cilia or filaments (Pl. 30. fig. 12, 18 *a*; Pl. 31. fig. 17): these are single, long, flexuous, and directed backwards; they frequently become adherent to the slide, and produce a sudden, backward motion of the animal. 4, setæ or bristles (Pl. 31. fig. 53): these are rigid, filiform, straight, and movable, but not vibratile, and are sometimes provided with a bulb at the base; they can be slowly raised or depressed, and serve for support, walking, or climbing. 5, styles (Pl. 32. fig. 17) are thick, straight, very movable setæ, without bulbs, sometimes having setiform branches; they neither rotate nor vibrate. 6, uncini or hooks (Pl. 50. fig. 13) are short, thick, curved, sometimes cleft setæ, serving for prehension, climbing, or creeping, and are bulbous and usually very thick at the base.

The long straight cirri of *Halteria* (Pl. 50. fig. 12), by which the saltation of these Infusoria is produced, probably come under the fifth series; but the foot of such genera as *Dysteria* (*Ervilia*, Duj.) (Pl. 30. fig. 52), which is used for locomotion, and also as a peduncle, is the homologue of the contractile sarcode in the hollow peduncle of *Vorticella*.

The flagellum of a marine *Ceratium* which was observed by Claparède, suddenly disappeared during a rapid contraction. It retracted into a spherical cavity, which was placed close to its point of insertion.

Nervous system.—None has been discovered. In the naked Infusoria, the sense of touch is diffused throughout the substance of the body. In others, it is particularly developed in the snout-like appendages of the body, and in the longer cilia, setæ, &c. The Infusoria are probably all sensible to light; and many of them exhibit, near the anterior part of the body, one or more coloured (mostly red) specks, which have been regarded as eyes; but they contain no distinguishable cornea, nor lens, nor are they connected with any appreciable substance comparable to nervous matter.

The pigment-spot is composed of a collection of minute and highly refracting granules, and in some species it is associated with Lieberkühn's "watchglass-like organ." This is a very minute, transparent, colourless and hard part of the cortical layer, which has its convex side towards the pigment-spot and the concave towards the head; but it is not dependent on the presence of the pigment, for some species possess it which have no pigment-spot, and *vice versâ*. Similar specks occur in the same situation in the spores of many Algæ; moreover the eye-specks are most distinct in those genera which are doubtful Infusoria. Hence it may be denied that they represent eyes; yet they bear considerable resemblance to the eyes of the Rotatoria and some Annelida; so that their true nature must be considered doubtful.

Digestive system.—On attentively examining Infusoria under a high power (1-4 to 1-8), a number of rounded spots are generally visible in the substance of the body; they are sometimes filled with a whitish granular matter; at others they contain Desmidiaceæ, Diatomaceæ, or other Algæ or bodies existing in the surrounding water. These have been called gastric vesicles, cells, spaces, vacuoles, or sacculi. They are only visible from their contents, and no membrane can be distinguished in them. If a little indigo or carmine be added to the water containing the Infusoria, these cavities will soon become filled and will be rendered very distinct; in the Plates they are represented as filled with these pigments.

On attentively watching them, they will appear to move around the body of the animalcule, sometimes two of them appearing to become fused into each other, or the contents of one to pass into another. Finally, the pigment will be seen to escape at some

part of the surface of the body, when the spots will vanish.

Different views have been entertained in regard to the nature of these spots or cavities. By the older observers, they were regarded as internal cavities into which water was admitted with any particles accidentally suspended in it, forming a means of bringing a greater extent of surface of the substance of the animalcule into contact with the water, and thus aiding in respiration.

Ehrenberg regarded them as dilated cæca, or portions of an alimentary canal (Pl. 31. fig. 38 *a*); whilst Dujardin considered them vacuoles arising in the same manner as those found in sarcode from whatever source derived; others have viewed them as cells floating loosely within the body. Most observers deny that they are portions of an alimentary canal, and that such canal exists, but adopt the opinion that they are cavities irregularly formed in the substance of the body by the introduction of the foreign matters, which are urged through it by its contractions, or moved onwards by its circulation. They are certainly not cells; otherwise they could not so readily admit particles of colouring-matter, &c., nor could their contents become fused together, as is sometimes seen to occur. They do not appear to be simply vacuoles filled in the ordinary manner by the surrounding liquid, because the pigment is accumulated in them in greater proportion than it exists in the liquid. In many Infusoria, the particles are admitted at a definite orifice, representing a mouth; this is round or oval, sometimes situated at the anterior end of the body, sometimes more posteriorly or even at the commencement of the posterior third of the body; and it is generally indicated by a circle, fringe, or some other definite arrangement of the cilia, which bring the particles towards it. Sometimes a distinct œsophagus lined with cilia leads to the internal substance, or to the sacculi. The course which the particles (apparently in gastric cavities) take is usually irregular, but sometimes tolerably definite, down one side of the body and up the opposite. The manner in which the undigested particles are evacuated is also an unsettled question; for whilst Ehrenberg and, more recently, Lachmann admit either the existence of a distinct excretory orifice, or evacuation by the mouth, other authors assert that these particles may be evacuated at any part of the surface of the body. According to the later observations of Lachmann, the cavity of the body of the Infusoria represents a large digestive cavity, as in *Hydra*, the contents constituting chyme, and there is a distinct mouth and anus.

The question then must remain whether there is a distinct alimentary canal, the walls of which are invisible on account of their extreme delicacy, or whether the particles drawn in by the cilia are urged at random through the substance of the body. The fact that distinct walls cannot be detected, is of no great weight in opposition to the former view, because the radiate contractile vesicles of *Paramecium* exhibit no walls, and are quite invisible when contracted; and the excretory vessels of *Distoma*, although having distinct walls, are seen to contract and then to vanish completely (Van Beneden).

It may be easily ascertained by experiment that some Infusoria will imbibe bisulphuret of mercury as readily as indigo or other matters, and thus would appear to be entirely deprived of any selecting power governed by a sense of taste; but some kinds would seem to have a sense of taste: *Coleps*, for instance, greedily devours the substance of crushed Entomostraca and their ova, becoming greatly deformed in the operation.

The vacuoles or digestive cavities are frequently very distinct when the animalcules are dead, and especially when dried. If the animalcules be fed with colouring-matter, on drying them, the vacuoles thus rendered distinct will be found to contain the pigment, which is in favour of Dujardin's view.

Surrounding the mouth in some Infusoria, as *Nassula*, *Prorodon*, *Chilodon*, and *Chlamidodon*, is a horny cylinder of rod-like bodies called teeth (Pl. 30. figs. 27 *a*, *b*, 29; Pl. 31. figs. 40, 45, 72): they do not appear to exert any triturating power; and their true signification is unknown. In some Infusoria an œsophagus is also present, as in *Vorticella*, *Carchesium*, *Epistylis*, *Oxytricha*, &c., consisting of a mostly funnel-shaped tube, often lined with cilia.

A coloured gastric juice has been described by Ehrenberg as existing in the gastric cavities. The colour, however, has been accounted for by Siebold as produced by refraction and the presence of aggregations of pigment-granules, mistaken for gastric cavities. This explanation we believe

to be inadmissible; and in some instances, at least (Pl. 30. fig. 19), the reddish-violet colour is real, and arises from the presence of solution of the colouring-matter of *Oscillatoriæ*, which is often different by reflected and transmitted light.

The particles of solid matter forming the food of the Infusoria, are usually drawn to the oral orifice by the action of the cilia. The manner in which *Actinophrys* takes its food is described under that head; but, from Lachmann's observations, the rays of *Acineta* are hollow suctorial organs.

In many of the organisms included among the Infusoria, the food-particles are ingested at any parts of the entire surface, or at certain parts only, no mouth being present.

Circulating system.—On closely watching almost any of the Infusoria, minute, mostly rounded, clear spots are seen in the substance of the body, disappearing and reappearing at pretty regular intervals. These are the *contractile vesicles*; they are of variable size, but about that of the gastric cavities. The nature of their contents, which is a colourless liquid, is doubtful. Dujardin regards it as consisting of water, and as existing in vacuoles similar to the vacuoles or gastric cavities; whilst Siebold and others find here a kind of rudimentary circulation of a nutritive fluid, comparable to the circulation of the blood. In certain Infusoria, as *Paramecium* (Pl. 31. fig. 56), this phenomenon is observed to take place between a central rounded and several elongated and radiating cavities, and the liquid contents are seen to be propelled from the former into the latter, and *vice versâ*. These contractile or pulsating vesicles or spaces, as they are called, never contain foreign particles; they are tolerably constant in position in the same species of Infusoria; and they do not rotate nor move like the gastric cavities; all of which facts are opposed to the notion of identity with the latter. The contracting vesicles of some species open externally through a canal; and in others a long internal vessel is continuous with them. They are found in some Algæ, as *Volvox*, *Chlamidomonas*, *Gonium*, *Syncrypta*, as in *Dinobryon* and *Euglena*, which would negative their relation to an animal circulation. Kent, however, considers the presence or absence of the contractile vesicle a ready means of distinguishing unicellular animal from vegetable organisms. Lieberkühn and Lachmann describe distinct vascular branches arising from the contractile vesicles, not penetrating the internal sarcode of the body.

Another kind of circulation takes place in some of the larger Infusoria. This is a rotation of the mass of the internal substance of the body. It has been observed in *Paramecium*, but only in those specimens having green corpuscles imbedded in the outer coat.

When almost any of the Infusoria are allowed to remain upon a slide until most of the water has evaporated, rounded and somewhat highly refractive globules will become evident at their margins (Pl. 32. fig. 2 *a*); these consist of the semifluid gelatinous sarcode forming the interior of the body, and they possess a remarkable tendency to the formation of vacuoles or cavities within them, which apparently become filled with the surrounding water. This fact is perhaps the strongest in favour of the formation of the gastric cavities and contractile vesicles within the body of the living animals in the same manner as supposed by Dujardin; which, however, is opposed, in the case of the contractile vesicles, by their tolerably constantly uniform position, and especially their remarkable form (as in the stellate vesicles of *Paramecium* &c., Pl. 31. fig. 56), and the manner in which the contents in the latter instance are propelled from one to the other, or from the radiate to the rounded vesicles.

Nucleus.—In the substance of the bodies of most of the Infusoria may be perceived a solid granular-looking body, of variable form, mostly rounded, elongate, or curved (Pl. 30. fig. 55; Pl. 31. figs. 37, 56; Pl. 32. fig. 26), sometimes branched (Pl. 32. fig. 25), which those who regard the Infusoria as consisting of simple cells consider a true nucleus, whilst Ehrenberg regarded it as a testis.

Nucleolus.—This is usually a small body, in or upon the nucleus, and with a high refractive power.

Propagation and reproduction.—The Infusoria increase in numbers by the following methods:—1. Fission or self-division. This occurs in (*a*) the perfect form of the animalcule, and (*b*) after it has become encysted. 2. Gemmation or budding. 3. Conjugation.

1. *Fission or self-division.*—(*a.*) Spontaneous division is either longitudinal (Pl. 32. fig. 37) or transverse (fig. 38). In both, the nucleus undergoes division, as well as the body. In the longitudinal division the process commences at one end of the body,

from which the cilia usually are retracted or disappear; a notch is first perceived, which afterwards becomes deeper, until the body is completely cleft; the two halves then acquire cilia, and assume the functions of perfect animals. In the transverse division, a median constriction appears first, followed by perfect separation, as in the last. During these processes of division, the animals sometimes continue their movements as usual; at others this is more or less interfered with. In *Vorticella* (Pl. 32. fig. 21 *a*), in which the process of longitudinal division may be conveniently watched on account of the comparative fixure of the animals by a pedicel, when the division is nearly completed a ring of cilia is formed near the attached end of the body, by the movements of which the new *Vorticella* is separated from the parent. The process is completed in about an hour.

Claparède and Lachmann state that the first process in the spontaneous division of *Vorticella* is the development of a fresh mouth-circle of cilia and a second contractile vesicle; then a partial division occurs, which is followed by fission of the nucleus and final separation of the two animalcules.

(*b.*) *Fission as part of an encysting process.*—Many of the Infusoria are observed to alter their form at certain periods, become rounded, lose or retract their cilia (Pl. 32. fig. 27), and to secrete all over their surface gelatinous matter, forming a coat or cyst enclosing them. While thus encysted, the substance of the body becomes divided, and gives origin to a number of germs, which are discharged by the bursting of the cyst (Pl. 32. fig. 34). They do not then resemble the parent, but are gradually developed, during ordinary growth, into its form. In some cases the progeny or brood become individually encysted within the parent cyst; it appears, however, that they are not discharged in this condition, but escape first from their own cyst and then from the parent, in which they leave their own exuviæ. Stein thinks that it was such broods that Ehrenberg mistook for the results of the increase by diffluence.

In *Trichoda lynceus* the encysting process appears subservient to a kind of metamorphosis of the individual, the animalcule which emerges from the cyst having characters in many respects different from the *Trichoda*, but no multiplication is effected either by subdivision or gemmation. The late Jules Haime described this multiplication by fission, the encysting of ova of the separate *Trichoda*, and the subsequent escape of a differently shaped creature, which became gradually developed into a form like *Aspidisca*.

2. *Gemmation* is not a general proces in the Infusoria. It is well seen in *Vorticella* (Pl. 32. fig. 26). The buds arise from near the posterior end of the body, and, when fully developed, liberate themselves by the formation of a posterior ring of cilia, as above mentioned.

3. *Conjugation.*—Balbiani supposed that male and female organs existed in many Infusoria, the former being represented by the nucleolus, which resolved itself into spermatozoa; the latter by the nucleus, which after sexual conjugation became converted into ova. Later researches, however, show that the conjugation is an ordinary fusion of the structures of two individuals without sexual relations. In the conjugating condition, the animalcules often closely resemble those undergoing division. Thus *Paramecium aurelia* multiplies to a great extent by self-fission, but only to a definite extent, for sooner or later they conjugate. They assemble upon certain parts of the containing vessel, and soon become coupled in pairs. They are closely adherent to each other, with their similar extremities turned in the same direction and their mouths closely applied. While thus conjugated, they continue moving with agility in the liquid, turning round and round upon their axes; but those which, like *Stentor*, are attached by a footstalk remain almost motionless. The conjugation lasts for five or six days. It is also stated that reproduction is effected by the breaking up of the nucleus into fragments which subsequently become developed into the parental form.

The metamorphosis of the Infusoria has been noticed above; but there is another method by which the individual is preserved for a time, the *encysting process without fission*. Many Infusoria at certain times undergo an *encysting process*, which apparently serves as a provision under circumstances which do not permit the continuance of their ordinary vital activity. The movements of the Infusoria diminish in vivacity, and the cilia are either lost or retracted; the surface of the body pours out a secretion which hardens around it, and the animalcule lives on and rotates within its cyst until the time for its escape arrives.

Some Infusoria live in very briny water; and some can exist at a temperature of 120° Fahr.; but their numbers diminish with the cold of winter, although a few can exist when frozen in ice. Hardy as they are as a class, it is therefore very remarkable to witness the succession and disappearance of different genera during a comparatively short time in infusions and natural waters.

Diffusion, &c.—When we consider that the multiplication of the Infusoria by division takes places according to a geometrical progression, also that they need only become encysted to produce swarms of germs, we can easily understand their rapid propagation in liquids; when also they will resist a degree of cold =8° F., and an elevated temperature of 260° F., or even desiccation, without destruction, and when their minute size is added, we can readily understand their almost universal diffusion.

As we have stated, a drop of water can scarcely be found which does not contain some Infusoria. Many of them will only live in fresh or sweet water, whilst others are found only in decomposing and even putrid water containing decomposing animal and vegetable substances; others, again, are only met with in salt or brackish water. Those existing in fresh water may be collected in ordinary wide-mouthed bottles, a drop of which may be removed by the dipping-tube; any individual one perceptible to the eye may be withdrawn by the same means. Their natural movements are best watched in the live-box; but these movements greatly interfere with the observance of the contractile vesicles and general minute structure, which is best seen when they are simply confined between the slide and cover, in a small quantity of water. A good plan for arresting their motions is that of warming the slide containing them over a candle or lamp for a short time. Many Infusoria live only in particular kinds of infusions, just as certain plants live only upon particular kinds of soil; and these infusions should be prepared by adding cold fresh water to the vegetable or animal subtances (the water being in considerable excess), and allowing the mixture to remain for a time. Even in infusions of many powerful poisons, as of Nux vomica, Cevadilla, &c., they will not be found absent; and Dujardin noticed that their development was greatly promoted by the addition of certain salts to the solutions, as phosphate and carbonate of soda, phosphate, nitrate, and oxalate of ammonia (really, the more recently so-called Pasteur's liquid); and this author was inclined to believe that some of these salts become decomposed in the presence of the organic matters, yielding nitrogen to the Infusoria; he also states that oxalate of ammonia disappears entirely under these circumstances.

The following are the most common Infusoria found in natural waters or infusions of vegetable or animal matters:—

Amphileptus fasciola.
Bodo saltans.
—— *socialis.*
Chilodon cucullulus.
Chilomonas paramecium.
Chlamidomonas pulvisculus.
Coleps hirtus.
Colpoda cucullus.
Cyclidium glaucoma.
Euplotes charon.
Glaucoma scintillans.
Leucophrys carnium.
—— *pyriformis.*
Monas crepusculum.
—— *gliscens.*
Monas guttula.
—— *termo.*
Oxytricha pellionella.
Paramecium aurelia.
—— *chrysalis.*
—— *colpoda.*
—— *milium.*
Polytoma uvella.
Stylonichia pustulata.
—— *mytilus.*
Trachelius lamella.
Trichoda pura.
Trichodina grandinella.
Uvella glaucoma.
Vorticella convallaria.
—— *microstoma.*

Some of the Infusoria are phosphorescent, and impart a luminous property to seawater. This has been distinctly observed in the following species:—*Prorocentrum micans*; *Peridinium michaelis*, *P. micans*, *P. fusus*, *P. furca*, and *P. acuminatum*, *Synchæta baltica*, and a doubtful species of *Stentor*.

Slender needle-like crystals of sulphate of lime have been observed affixed to the bodies of the Infusoria, probably derived from the water in which they live.

The Infusoria are difficult of preservation. Some of them will exhibit their characters when dried, the cilia and vacuoles remaining very distinct, as also the striæ upon the integument. Others are but little changed by a concentrated solution of chloride of calcium, or dilute glycerine. Solution of chromic acid or of bichloride of mercury will answer with some of them, although they are rendered somewhat opaque by these reagents, which is sometimes an advantage where they are naturally very transparent. Osmic acid has been found very useful in killing them so instantaneously, that the cilia remain as in the living state. A saturated solution of iodine in iodide of potassium acts like osmic

acid. The juice of the common horse-shoe geranium is a very old agent for effecting the same purpose (Kent). The various colouring-matters—eosine, hæmatoxyline, aniline, picrocarmine, &c.—serve to distinguish the nuclei &c.

The chemical properties of the sarcode or protoplasm of the lower animals and plants, are very important to be noted. For although proteine matter exists in both, yet in the vegetable forms this is in very small proportion, and the motile power is correspondingly feeble. Solution of potash or ammonia dissolves the proteine matter, and as the animal organisms are almost entirely composed of this, their bodies vanish; while in the case of vegetable organisms, the preponderating cellulose matters remain, the organism apparently undergoing no change. Probably if this test were applied to the Flagellate forms, few would be left among the Infusoria; and it should be used in all cases.

The systematic arrangement of the Infusoria is in an unsettled state. The characters of the genera and species laid down by Ehrenberg were mostly founded upon analogies rather than upon observation. Those proposed by Dujardin were far more accordant with observation; but unfortunately this author so altered the names proposed by Ehrenberg, raking up old and long-forgotten names, which are moreover often doubtfully identical with those for which they are substituted, and sometimes using similar names for totally different genera and species—that great confusion was produced, and the two systems are not reconcilable.

The later system of Claparède and Lachmann was a great improvement upon the former ones; and this has been strengthened and improved by those of Stein and Kent. The standard work of the latter is replete with laborious research; and contains descriptions and figures of all the species.

In descriptions of genera and species the anterior part of the body is that near which the eye-specks are situated, and which is directed forwards; the surface towards which the eye-specks are nearest forms the back or dorsal surface. A narrowing of the body posteriorly, so as to give rise to a prolongation, forms a tail; and an anterior prolongation of the dorsal surface is described as a forehead or upper lip, according to its situation.

According to the system of Claparède and Lachmann, the Infusoria are arranged as follows:—

- **No flagellum**
  - Cilia or bristles in the adult; no suckers — Order I. CILIATA.
  - No cilia in the adult; suckers present — Order II. SUCTORIA.
- **One or more flagella**
  - Cilia also present — Order III. CILIO-FLAGELLATA.
  - No cilia — Order IV. FLAGELLATA.

Order I. Ciliata.

- **Mouth and œsophagus open in repose, the latter ciliated, neither dilatable**
  - Mouth and anus in a common fossa. Buccal spiral dexiotrope — 1. Fam. *Vorticellina.*
  - Mouth and anus not in a common fossa. Buccal spiral læotrope
    - Buccal cilia only
      - No other locomotive organs than the buccal cilia — 2. Fam. *Urocentrina.*
      - Crawling locomotion — 3. Fam. *Oxytrichina.*
    - Cilia all over
      - Body bell-shaped, several rows of buccal cilia — 4. Fam. *Tintinnodea.*
      - Buccal spiral forming one turn only
        - Buccal cilia strongest — 5. Fam. *Bursarina.*
        - No buccal spiral — 6. Fam. *Colpodea.*
- **Mouth and œsophagus very dilatable; œsophagus not ciliated.**
  - Body entirely or mostly ciliated
    - A foot — 7. Fam. *Dysterina.*
    - No foot
      - No carapace — 8. Fam. *Trachelina.*
      - A carapace — 9. Fam. *Colepina.*
  - Body glabrous, one row of cilia around the mouth — 10. Fam. *Halterina.*

Order II. Suctoria, or ACINETINA.

- **Suckers not on a proboscis or tube.**
  - Suckers simple
    - Not forming a branched colony.
      - No sheath
        - A peduncle — 1. Genus *Podophrya.*
        - No peduncle
          - Free — 2. Genus *Sphærophrya.*
          - Fixed — 3. Genus *Trichophrya.*
      - A sheath
        - A peduncle — 4. Genus *Acineta.*
        - No peduncle — 5. Genus *Solenophrya.*
    - Forming branched colonies — 6. Genus *Dendrosoma.*
  - Suckers branched — 7. Genus *Dendrocometes.*
- **Suckers on a long retractile tube** — 8. Genus *Ophryodendron.*

Order III. Cilio-flagellata. PERIDININA.

A transverse groove	The two portions of the carapace equal in length	Carapace with prolongations	1. Genus *Ceratium*.
		Carapace without appendages	2. Genus *Peridinium*.
	The two portions unequal	Borders of the notch turned up and lamelliform	3. Genus *Dinophysis*.
		Borders not turned up	4. Genus *Amphidinium*.
No groove. Cilia on the anterior margin			5. Genus *Prorocentrum*.

Kent arranges the Infusoria thus:—

* FLAGELLATA.
† Ingestion by all the surface.
Order 1. *Trypanosomata*. A rudimentary flagellum, and an undulating membrane.
Order 2. *Rhizoflagellata*. A flagellum and lobate pseudopodia.
Order 3. *Radioflagellata*. A flagellum and radiate pseudopodia.
Order 4. *Flagellata Panstomata*. Flagella the only motile organs.
†† Ingestive area anterior.
Order 5. *Choano-flagellata*. A flagellum and a collar.
††† A distinct mouth.
Order 6. *Flagellata Eustomata*. A flagellum only.
Order 7. *Cilio-flagellata*. A flagellum and cilia.

** CILIATA.
Order 1. *Holotricha*. Cilia all over the body, uniform.
Order 2. *Heterotricha*. Cilia general, but the oral larger.
Order 3. *Peritricha*. Cilia forming a spiral or circular wreath.
Order 4. *Hypotricha*. Cilia ventral.

*** TENTACULIFERA (Acinetina.)
Order 1. *Suctoria*.
Order 2. *Actinaria*.

Kent defines 79 families, and 359 genera; of which our space will only allow a sketch under the respective heads.

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INFUSORIAL EARTH.—The fossil deposits of Diatomaceæ were formerly so called.

INJECTION.—The art of filling the vessels and other minute tubular organs of animals with coloured substances, by which their relative size, arrangement, and relation to the surrounding parts may be made manifest. The substances used for injections consist of powders, mostly insoluble, mixed with some liquid which holds them in suspension or solution; and while in this state they are driven into the vessels by a syringe or some similar contrivance. We shall first give a sketch of the apparatus requisite, and the method of making the liquids for injecting the tissues of the Vertebrata, before treating of the process itself.

Syringe.—Two or three syringes are requisite, of various sizes, adapted to the volume of injection to be thrown into the vessels, or the size of the animal or part to be injected. In general, one holding 6 drms. or 1 oz., and another holding about 2 oz. will be found the most useful. Each syringe must be provided with two rings at the upper part next the handle, so that it may be firmly and easily held. The syringes when in use should be surrounded by a roll or two of flannel fastened with string, to prevent their rapid cooling; and the flannel should be kept as dry as possible during the process.

Sometimes a much smaller syringe, called an oyster-syringe, is useful for injecting very small and soft animals.

The plug of the piston is adapted to the tube of the syringe by two pieces of washleather, the method of replacing which must be learnt at the time the syringe is bought,

for it is difficult of description. The plug must work air-tight in the tube, which may be proved by depressing the handle as far as possible, then closing the nozzle of the syringe with one finger, withdrawing the handle to its fullest extent, and letting it go, when it should fly entirely home. If this does not take place, the plug must be re-leathered.

The handle of the syringe should be graduated; *i. e.* transverse lines should be scratched upon it with the end of a file, or in some other way, so that when its descending movement is so slow as not to be felt by the hand, it may be indicated to the eye.

The syringes, and in fact all the mechanical apparatus requisite for injection, may be purchased of Mr. Neeves, Regent Square, or of Mr. Ferguson, Smithfield.

The syringe must accurately fit the stop-cocks and pipes.

Injecting-pipes.—These must be of various sizes, to suit those of the vessels into which they are to be introduced; they are furnished with two short transverse arms, by which they may be tied to the vessel. The smallest pipes which are made, easily become stopped up unless thoroughly cleansed after use; to remove any obstruction, a very fine "broach"-needle made of watch-spring is required, and may be procured of Mr. Ferguson as above.

Stopcocks.—One or two of these are useful in stopping the injection from returning, when the syringe is removed, or force ceases to be applied to it.

Forceps.—One or two pairs of small tenaculum forceps must be at hand; these are noticed in the INTRODUCTION, p. xxv.

Jars or other vessels for holding the injection. These may consist of confectioners' jam-pots, or may be made of tin. The former have the advantage of retaining the heat for a considerable time. When in use, the jars must be placed in a water-bath, or in a tin vessel containing water, and placed over a stove.

Stirring-rods.—These must be made of wood.

Size.—The colouring-matters used for the coarser injections are mostly insoluble powders. These are usually mixed with size or some form of solution of gelatine, which holds them in suspension better than water.

The size mostly used is Young's patent size, and it is sold in the shops. It should be clear and fresh. Those who cannot obtain this may prepare its equivalent by dissolving 1 part of glue in 8 or 10 parts of water with the aid of heat.

The principal liquid injections used may be arranged according to their colours. In regard to the proportions of the colouring-matter to that of the size, it must be remarked that these vary as used by different injectors; and that, in general, when the vessels to be injected are very minute, and the objects are to be viewed by transmitted light, the size should be thinner, and the proportion of pigment less, than under the opposite conditions. When the injection is directed to be strained, this must be done through a piece of new flannel wrung out of hot water, or through a "tammy sieve," which is more convenient. In preparing the injections, great care must be taken that the jars are perfectly clean, and that no old injection remains adherent to them. The colouring-matters, whether dry or dissolved, should be added to the size previously warmed in the water-bath, or the tin vessel mentioned above; and the whole should be stirred until thoroughly incorporated. When trituration is spoken of, it must be understood that the rubbing in a mortar should be continued for a long time, until the substance is reduced to the finest possible state of powder.

Harting recommends preparing a stronger size than that mentioned above, containing 1 part of glue to 4 of water, and that the chemical substances be dissolved in the additional water requisite before being added to the size, which would seem to be preferable; but we have found the method recommended to answer every purpose, and it has the advantage of greater simplicity.

Red Injection.—This is best made with vermilion (bisulphuret of mercury), which before use should be carefully examined as to its purity from minute colourless crystalline particles, by viewing it by reflected light, when they are easily detected. When the vessels to be injected are very minute, the vermilion is best previously levigated, *i. e.* triturated in a mortar with a small quantity of water, the whole being afterwards thrown into a large amount of water, and allowed to settle for a few seconds, so that the coarser particles still left may subside; the upper portions of the liquid, containing the finer parts of the powder, are then poured off and allowed to settle, the supernatant water being again poured off,

and either allowed to dry slowly, or mixed while moist with the size.

The ordinary proportions for this injection are:—

Vermilion 1½ oz., Size 1 lb., or
Vermilion 164 grs., Size 4 oz.

Stir the colouring-matter well with the warmed size, then strain.

Other red colouring-matters have been used, but they cannot be recommended. Among them may be mentioned:—the basic chromate of lead, prepared by boiling the neutral chromate with caustic or carbonate of potash; the biniodide of mercury, formed by decomposing bichloride of mercury with iodide of potassium in atomic proportions; and the oxysulphuret of antimony.

Yellow Injection.—This is prepared with the chromate of lead (chrome-yellow), as follows:—

Take of

Acetate of lead.....	380 grs.
Bichromate of potash	152 grs.
Size	8 oz.

Dissolve the lead-salt in the warm size, then add the finely powdered bichromate of potash.

As thus prepared, some of the chromic acid remains free, and is wasted, which may be obviated by preparing the chromate of lead with the chromate of potash in the proportions of

Acetate of lead	190 grs.
Chromate of potash (neutral)	100 grs.
Size.....	4 oz.

or

Acetate of lead	196 grs.
Bichromate of potash	76 grs.
Carbonate of potash	41 grs.
Size.....	4 oz.

Thiersch used chromate of potash and nitrate of lead.

The chromate of lead prepared from the bichromate of potash alone has the deepest colour, and is that generally used.

White Injection.—The best white injection is made with carbonate of lead, thus: take of

Acetate of lead	190 grs.
Carbonate of potash	83 grs.
Size.....	4 oz.

Dissolve the acetate of lead in the warm size and filter; dissolve the carbonate of potash in the smallest possible quantity of water, and mix it with the size.

143 grains of carbonate of soda may be substituted for the above amount of carbonate of potash.

A white injection (very inferior) may also be made with carbonate of lime, by taking of

Fused chloride of calcium ..	111 grs.
Carbonate of potash	167 grs.
Size.....	4 oz.

286 grs. of carbonate of soda may be substituted for the carbonate of potash.

Blue Injection.—In whatever manner prepared, this cannot be in general recommended; for blue pigments reflect so little light, that the injections made with them appear almost black. The only one worthy of mention is prussian blue suspended in oxalic acid, which may be prepared with

Prussian blue	73 grs.
Oxalic acid	73 grs.
Size	4 oz.,

the oxalic acid being first finely triturated in a mortar, the prussian blue and a little water afterwards added, and the whole then thoroughly mixed with the previously warmed size.

General method.—When the part for injection has been selected, the first proceeding is to fix the pipe in some vessel; and the larger this is, the more easily will the pipe be inserted and fixed. When the vessel has been isolated, if it has been cut across, the pipe should be introduced at its end, pushed up as far as possible, and a piece of not too thin silk thread passed beneath and tied around it, enclosing of course the nozzle of the pipe; the ends of the silk should then be wound round the arms of the pipe and again tied, so that the pipe may remain firmly fixed in the vessel. If the vessel be not divided, a longitudinal slit should be made in it for the introduction of the pipe, the thread being passed round it by a curved needle, the eye of which carries the thread. As soon as the pipe has been fixed in the vessel, all other vessels communicating with it should be tied round with silk thread or closed in some other way, that the injection may not escape: sometimes it is requisite to enclose a part of the tissue itself in the ligature; in other instances their closure may be effected by fusion of the tissue at the spot from which the injection might escape, by the application of a red-hot iron.

The organ or part to be injected is then immersed in warm water, in order that it may become heated throughout; and if it be large and of considerable thickness, this may take some time; and fresh warm water must be added at intervals to keep it at the same temperature, which should be about as great as can be borne by the hand. If the water be too hot, the vessels and tissues will be rendered brittle, and the whole will be spoiled. Moreover the part should not be kept longer in the water than is absolutely requisite, for the same reason. While the tissue is becoming heated in the water, the injection should be prepared, or be heated if previously prepared, and kept constantly stirred; the stopcocks should also be immersed in hot water.

As soon as all is ready, the stopcock turned open, is fixed to the syringe, and some hot water is drawn into and expelled from the syringe two or three times, so that it may become properly heated. It is next filled with the injection, taking special care that no air be allowed to enter, to avoid which it must be filled, emptied, and refilled several times, the nozzle being kept beneath the surface of the injection. The syringe is then taken in the hand, a little of the injection being forced out at the nozzle of the stopcock, which is next loosely inserted into the pipe; and some of the injection being urged into it by depressing the handle, the pipe is filled, and the nozzle introduced into it. Very gentle pressure is then made upon the piston, so that the injection may be driven into the vessels; and this must be continued until the piston ceases to be felt to move, or is seen not to enter the syringe further, by watching the graduations on its handle. When this is found to be the case, firmer pressure must be made and the effect noticed. But practice can alone guide as to the time at which the pressure should cease, or when as much injection has been forced into the preparation as is required. Some judgment may be made from the colour assumed by the preparation; or, the stopcock being turned off, and the syringe separated from it, the preparation may be examined with a low power, while laid upon a large glass plate.

During the continuance of the process, the preparation, the injection, and the pipes must be kept at the original temperature; and should any part be found to become cool, the stopcock must be turned off, the syringe separated, the injection returned to the jar, fresh warm water added to the preparation, and the whole process recommenced as at first.

If, during the process, there should be an escape of the injection from any part, this need not cause alarm if slight; should it, however, be considerable, it must be stopped by one of the means pointed out above—perhaps by the orifice of the vessel and surrounding parts being grasped by the tenaculum-forceps, and the whole included in a ligature. If the preparation be small, notwithstanding a considerable escape of the liquid, a very good injection may often be made.

As soon as the injection is completed, a ligature should be placed around the vessel into which the pipe is inserted, beyond its nozzle; the pipe is next removed, and the preparation should be immersed in clean cold water, and kept in it for an hour or two at least. It may then be withdrawn and sections made of it with a knife, razor, or some other instrument.

Large pieces of injected preparations are best preserved in a stoppered bottle containing dilute spirit of wine (1 spirit to 2 water, or equal parts). See also PRESERVATION.

When two or more sets of vessels are to be injected, the process should be continued uninterruptedly until completed; *i. e.* as soon as the injection of one set has been completed, another pipe should be at once inserted into one of the other set, and so on. Or what is better, if possible, the pipes for the two or three sets should be introduced and fixed at once, before the process is commenced.

As regards the period after death at which the injection should be commenced, this varies with the kind of organ or tissue: if it be delicate, the sooner the better; whilst if the vessels be comparatively large, by some little delay the tissue becomes somewhat softer and more yielding.

When a tissue has been successfully injected, the vessels appear plump and well filled by reflected light. But if they are not so, the preparation has its value; for it will perhaps well display the relative positions of the capillaries to the surrounding tissues when viewed by transmitted light—often even better than when the injection has been what is termed successful. In fact, when the vessels are well filled, little more can be seen in general than the relative situation of the vessels to each other.

The choice of the kind of injection is not a matter of much importance, except as regards the facility with which the vessels are filled. The arteries are in general filled with red injection, the veins with yellow, and the ducts (as the urinary tubules) with white. The chromate of lead is perhaps the finest injection and runs best, except that made with prussian blue and oxalic acid, which does not reflect enough light where the vessels are to be viewed by reflected light, although when these are very minute and can be conveniently viewed by transmitted light it may be preferred.

It may be remarked that, if it be required to use a yellow (the chromate) injection and a white (the carbonate of lead) for two sets of vessels in one preparation, the chromic acid in the former must previously be completely neutralized; otherwise it will render the white (carbonate of lead) yellow. This may, however, be avoided by substituting the carbonate of lime for that of lead.

As microscopic objects, nothing can exceed the beauty of injected preparations; and to be seen in their greatest perfection they should be dried, moistened with oil of turpentine, and mounted in Canada balsam. At the same time it must not be forgotten that, when dried and preserved in this manner, the real arrangement of the vessels is more or less distorted, those lying in different planes being brought into the same, and so on.

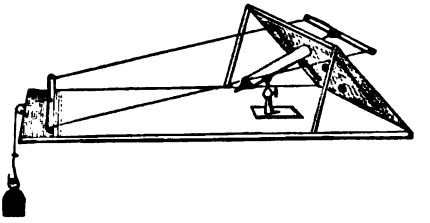
In Plate 39. figs. 33, 34, and 35, we have given representations of three injections viewed by reflected light,—fig. 33 being taken from the liver of a cat, in which injection made with vermilion was thrown into the portal vein, and that with chromate of lead into the hepatic vein; fig. 34 is a portion of the lung of a toad injected with vermilion; and fig. 35 is a portion of the kidney of a pig, the arteries and Malpighian tufts (KIDNEY) being filled with the red (vermilion) injection, and the urinary tubules with the white (carbonate of lead).

Self-injection occupies an important position amongst the various modes. The vascular system of the frog may be injected by inserting a pointed glass tube filled with the coloured injecting fluid into the vena cava. The fluid passes into the heart, and is distributed through the system by the force of the heart itself. The biliary vessels of living animals have been injected by means of colouring-matter introduced into the jugular veins.

Toldt has injected the lymphatics on this system; and he introduces a granular pigment (aniline) precipitated by water from its alcoholic solution into the blood.

The perfect injection of an organ or an entire animal of considerable size is a tedious and fatiguing process. We have therefore contrived a very simple piece of apparatus, which any one can prepare for himself, and which effects the object by mechanical means. It consists of a rectangular piece of board, 2′ long and 10″ wide, to one end of which is fastened an inclined

Fig. 360.



piece of wood supported by two props, as shown in fig. 360. The inclined portion is pierced with three holes, one placed above the other, into either of which the syringe may be placed—the uppermost being used for the larger, the lowermost for the smaller syringe; and these holes are of such size as freely to admit the syringe covered with flannel, but not to allow the rings to pass through them. The lower part of the syringe is supported upon a semiannular piece of wood, fastened to the upper end of an upright rod, which slides in a hollow cylinder fixed at its base to a small rectangular piece of wood; and by means of a horizontal wooden screw, the rod may be made to support the syringe at any height required. The handle of the syringe is let into a groove in a stout wooden rod connected by means of two catgut strings with a smaller rod, to the middle of which is fastened a string playing over a pulley, and at the end of which is a hook for supporting weights, the catgut strings passing through longitudinal slits in the inclined piece of wood.

In use, the part to be injected is placed in a dish of some kind containing warm water, supported at a suitable height beneath the end of the syringe by blocks of wood. The syringe is then filled with injection, passed through the proper aperture in the

inclined board, and fitted to the pipe, the stopcock being turned off. The rod and strings are next adjusted, and, a suitable weight being added, the stopcock is very slowly turned on, and the effect watched. If the handle of the syringe does not move, more weight must be added, the stopcock always being turned off when this is about to be done.

A great advantage of this apparatus is, that it sets at liberty the hands, so that an escape of injection may be arrested, or fresh warm water added, without interruption of the process.

Other automatic methods have been proposed, as that of Rutherford, which is this:—

A large jar of water is attached to a pulley, so that it can be elevated to any height. A long elastic tube with a stopcock is connected with the interior of the jar, near its bottom, so that the water may flow out when required. The other end of this tube transmits the water into a large Woulfe's bottle having three apertures. The water flows in by one aperture, through a glass tube which passes to the bottom of the bottle. The air is thereby forced through the other two apertures, one communicating with a mercurial manometer for indicating the pressure, the other transmitting the air through an elastic tube to a second Woulfe's bottle containing the injection. This bottle has two apertures. The air is forced upon the surface of the liquid, and a glass tube, reaching nearly to the bottom of the bottle, transmits the injection to an elastic tube joined to a glass or metal nozzle placed in the vessel. Any number of Woulfe's bottles may be added, so that different injections can be thrown in at the same time. The pressure can be regulated with the greatest nicety.

When it is not required to fill the capillaries, but only the smaller arteries or veins, the colouring-matters need not be prepared by double decomposition, and the following substances may be used:—

Red.—Size 1 lb., vermilion 2 oz.
Yellow.—Size 1 lb., King's yellow (orpiment) or chrome-yellow 2½ oz.
White.—Size 1 lb., flake-white 3½ oz.
Blue.—Size 1 lb., fine blue smalt 6 oz.
Black.—Size 1 lb., lamp-black 1 oz.

Injections made with transparent solutions are now largely used, the objects being viewed with high powers, by transmitted light. Fine gelatine is usually employed, and is dissolved in water over a water-bath, the colouring-matter already in solution being then added, and the mass introduced into a Woulfe's bottle, which must be immersed in a warm water-bath. The injection takes long to do; and the warmth must be kept up. The colouring matters usually employed are prussian blue and carmine—the latter not in a state of complete solution, but partly precipitated by the addition of a little weak acid from its alkaline solution. Thiersch, whose transparent injections are wonderful, uses a transparent yellow, and green,—the former from chromate of potash and nitrate of lead, and the latter from a mixture of this with blue. Beale, in order to avoid the injecting of warm fluids, uses colouring-matter, water, glycerine, and traces of hydrochloric acid; afterwards the injected mass is placed in absolute alcohol.

Carter's carmine injection is made thus:—dissolve 60 grains of pure carmine in 120 grains of Liq. Ammon. fort., and filter if necessary; mix with this 1½ oz. of hot solution of gelatine (1 to 6 of water); mix another ½ oz. of the gelatine solution with 86 minims of glacial acetic acid, and drop this little by little into the solution of carmine, stirring briskly the whole time. Dry, or harden in solution of chromic acid; cut with a sharp razor, and mount in Canada balsam.

Beale's fine blue injection is made with

Glycerine	1 oz.
Spirit of Wine	1 oz.
Ferrocyanide of potassium	12 gr.
Tinct. or sol. of perchlor. iron	1 dr.
Water	4 oz.

Dissolve the ferrocyanide in 1 oz. of the water and the glycerine, and the iron in another oz. Mix gradually, adding the iron to the ferrocyanide. Then add the spirit and the rest of the water.

For very fine injections, the mixture may be diluted with 3 oz. of glycerine, and half the quantity of ferrocyanide and iron used.

The ferridcyanide of potassium is often used, forming Turnbull's blue, which is brighter and less liable to fade. This is made with ferridcyanide of potassium 10 grs., sulphate of iron 5 grs., glycerine 2 oz., water 1 oz., and alcohol 1 drachm.

Numerous other fine injections are described by Beale and Frey.

The tissues of the Invertebrata are so soft, that the ordinary syringes and pipes can rarely be used for injecting them, and recourse must be had to a finer and lighter form of apparatus. This may consist of a fine trochar, with a needle. In using it, the small vessel through which the injection is to be thrown, is held with forceps against the end of the trochar, and punctured with the needle. The trochar is next directed into the puncture, and the needle withdrawn. The small nozzle of a syringe is then introduced into the upper end of the trochar, and the injection thrown in. A form proposed by Harting consists of a common glass pipette of moderate width, and of a caoutchouc tube the smaller end of which is fastened by means of thread to the broader end of a fine, curved, glass nozzle. In using this apparatus, the pipette is first filled with the injection, and its lower portion introduced into the broader end of the caoutchouc tube, which, from its conical form, it accurately closes.

Different liquids for injection are also usually requisite; and many have been recommended. Among these may be mentioned:—1, indigo, triturated with oil and diluted with oil of turpentine; 2, oil-paints diluted with oil of turpentine; 3, infusion of logwood (*Hæmatoxylon*); 4, solution of carmine in size or in ammonia; and 5, solution of alkanet in turpentine.

A considerable escape of the injection is often unavoidable in these cases, and must therefore not be heeded.

Some injectors simply introduce the injection into the dorsal vessel or lacunæ, whence it is propelled to all parts of the body by the circulation. Thus Agassiz says that if the indigo injection (1) be introduced in this way into insects, it is seen to circulate almost instantaneously in every part of the body, and on subsequently opening the insect all parts of the body are found to be coloured. We believe that Blanchard also adopts this method. Probably the best injections for this purpose would consist of alkanet and turpentine.

Injections may be preserved either in the dry or wet state. For the former, sections should be made, thoroughly dried upon slides, then moistened with oil of turpentine, and mounted in balsam. For preservation in the wet state they must be mounted in cells while immersed in dilute spirit, Goadby's B. solution, or in chloride of zinc (see PRESERVATION).

We have not space to give a list of injected preparations; they are all very beautiful, but we can only notice a few of the most interesting. For practice in the art of injecting, we may recommend the kidney of a sheep or pig,—one system of vessels being alone filled with red or yellow injection; and this should be the arterial. Afterwards, in another kidney, the urinary tubules may be injected first, with white injection, and subsequently the arteries with red or yellow. A portion of the small intestine, exhibiting the general capillaries, with the plexuses of the villi, forms a beautiful object as prepared from the rabbit, the rat, &c. Among other preparations may be mentioned:—the liver of various animals, as the cat, the rabbit, &c.; the lungs of the cat, rabbit, &c., in which the capillaries are very minute; those also of reptiles, as the frog, triton, boa, and other snakes, in which they are coarser, but very beautifully arranged; the lungs of birds; the kidneys of the frog and triton; the web of the frog's foot; the ciliary processes and choroid coat of the eye; the gills of the eel and other fishes; the lungs of kittens, &c. which have not breathed, the air-cells being injected from the trachea; the skin of the frog, and especially of the triton, &c.

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INODER'MA, Kütz.—A genus of Palmellaceæ (Confervoid Algæ).

Char. Cells oblong, usually in longitudinal rows, loosely united by a soft jelly; thallus gelatinous, membranous, irregularly expanded.

I. lamellosum. On submersed wood and stones, everywhere.

BIBL. Rabenhorst, *Fl. Alg.* iii. p. 37.

INOME'RIA, Kütz.—A genus of Oscillatoriaceæ (Confervoid Algæ) with calcareously hardened incrusting fronds, growing on stones in fresh water. Fronds composed of vertical, parallel, whip-shaped filaments, with the sheaths obscure, connected together, and decomposed into very slender fibrils above. Kützing supposes his *I. Rœmeriana* to be synonymous with Hassall's *Lithonema crustaceum.*

BIBL. Kütz. *Sp. Alg.* 343, *Ic. Phys.* ii. pl. 83; Hassall, *Algæ*, 266, pl. 65. fig. 3; Rabenhorst, *Fl. Alg.* ii. 223.

INOSITE.—Or muscle-sugar, is a colourless crystalline substance, occurring in the muscular tissue of the heart, in the liver, the lung, kidneys, and brain; and in plants, in grape-juice, wine, and haricot-beans. The crystals form rhombohedra, and are soluble in water, but not in alcohol or ether.

INSECTS.—A class of invertebrate articulate animals.

Char. Head distinct, furnished with two antennæ; three pairs of legs; respiratory organs consisting of tracheæ; cutaneous skeleton composed of chitine.

Insects are distinguished from the Arachnida by the head being distinct from the thorax, and the presence of antennæ; and from the Crustacea by the respiratory organs consisting of tracheæ.

The body consists usually of thirteen segments or somites—one for the head, three for the thorax, and nine for the abdomen, the legs being attached to the second, third, and fourth segments.

The cutaneous skeleton or integument of insects probably consists of three layers—an outer epidermic, an intermediate pigment, and an internal fibrous layer; but consisting as it does of chitine, it is very imperfectly resolvable into its elementary components. The epidermic layer often presents a distinct cellular aspect (Pl. 35. fig. 30 *a*), sometimes the cells appearing as if flattened and overlapping (Pl. 35. fig. 30 *c*) and their free margins fringed with minute hairs (fig. 30 *b*). In other instances the epidermis appears uniform and structureless. In its deeper portion the epidermis is often strongly coloured by a resinous pigment, which is removable by prolonged maceration in solution of potash or in oil of turpentine. Beneath these imperfectly separable layers, is another representing probably the cutis, and consisting mostly of numerous secondary layers made up of fibres, running parallel or interlacing, and leaving fissures and tubes between them, sometimes presenting a stellate appearance: these fibres may be separated by maceration in caustic potash.

The outer surface of the integument of insects is usually furnished with processes of various kinds, as tubercles, hairs, spines, scales, &c. (see HAIRS and SCALES). The inner surface also gives off processes, which form a kind of internal skeleton, serving for the attachment of muscles, &c. In sketching the various parts of which the skeleton is composed, it must be understood that they are not always equally distinct, and that upon their degree of development, form, and general structure the characters of the families, genera, and species are mainly founded.

The *head* (fig. 361 *a*) consists of an upper anterior portion (Pl. 33. fig. 1 *d*), the clypeus, and an upper posterior portion (fig. 1 *b*), the epicranium or vertex, which are sometimes separated by a suture; a posterior portion or occiput (fig. 2+), by which the head is articulated with the prothorax; and a posterior inferior portion (fig. 3 *n*), the gula.

The *eyes* are situated upon the upper, anterior, or lateral parts of the head, and are of two kinds, simple and compound. The simple, called ocelli or stemmata (Pl. 35. fig. 2 *a*; Pl. 33. fig. 24 *b*), are usually from one to three in number, but sometimes are numerous in larvæ; they appear like shining smooth specks (Pl. 33. fig. 4), and usually form a triangle behind or between the compound eyes. They consist of an arched, round, or elliptical cornea, behind which is a conical or cylindrical lens, which is surrounded by a layer of pigment of various colours, resembling a choroid membrane, and is in connexion with a filament of the optic nerve.

The two compound eyes (fig. 361 *b*) are large, usually round or kidney-shaped (Pl. 33. figs. 1 *c*, 3 *c*), situated upon the upper and outer part of the head, and are sometimes so large (as in the Diptera, *Libellula*, &c.) as almost or quite to touch each other in front. They may be regarded as composed of numerous simple eyes closely aggregated; their corneæ vary in thickness, are but slightly arched, quadrangular or hexagonal in form, and in immediate contact laterally. Hence the compound cornea, when viewed from before or behind, presents the appearance of a membrane with numerous beautifully regular six- or four-sided facets (Pl. 33. figs. 5 *a*, *b*). The facets are very variable in number; but often many thousands are present. They are occasionally broader in front than behind, and are sometimes doubly convex (as in the Lepidoptera), at others concavo-convex (in *Libellula*, Pl. 33. fig. 6 *c*); but usually the surfaces are parallel. The cornea possesses a laminated structure.

Behind each cornea is a transparent cone (Pl. 33. fig. 6 *), representing a crystalline lens, the apex of which is imbedded in a transparent rod or pyramid laminated in structure, corresponding to a vitreous humour; and this is probably continuous with

a branch of the optic nerve. The length of the lens is variable, in the Diptera being very short, whilst in the Coleoptera and Lepidoptera it is five or six times as long as broad, and in *Libellula* it even exceeds this length. The compound cone, consisting of the lens and vitreous humour, is surrounded by a sheath of pigment, forming a

Fig. 361.

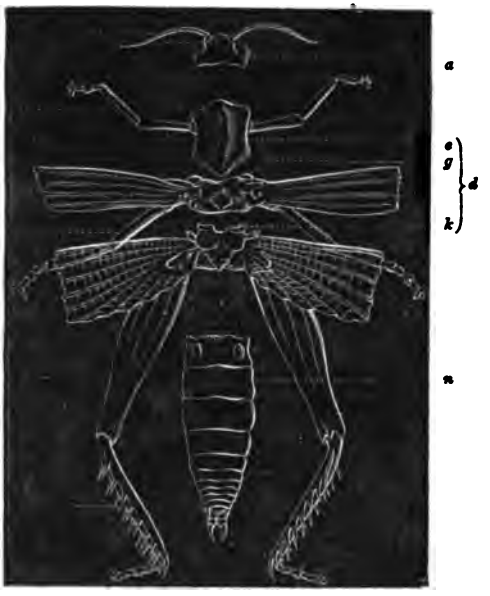


Diagram showing the principal parts of the cutaneous skeleton of a grasshopper.

a the head, with the eyes *b* and the antennæ *c*; *d*, the thorax, consisting of *e* the prothorax, to which the first pair of legs *f* are attached; *g*, the mesothorax, to which the first pair of wings *h*, and the second pair of legs *i* are attached; *k*, the metathorax, to which the second pair of wings *l*, and the third pair of legs *m* are attached; *n*, abdomen; *m*, femur; *o*, tibia with its spines, and *p* tarsus with its claws.

choroid membrane (Pl. 33. fig. 6*r*), in which numerous tracheæ ramify; this extends over the front of the base of the cone, leaving, however, a small pupillary space or pupil, which is separated from the back of the cornea by an anterior chamber.

The *antennæ* are noticed under ANTENNÆ.

The *trophi* or organs of the mouth vary in structure in the different orders, but the following form the typical parts: an upper central single piece, the labrum, or upper lip (Pl. 33. figs. 1 *e*, 3 *e*, 22 *a*), forming the upper boundary of the mouth, and articulated at its base with the clypeus. A lower single piece, forming its lower margin, called the labium or lower lip (Pl. 33. fig. 2 *i*, *l*, *m*). This consists of several parts: the most posterior is the mentum (fig. 3 *l*), which is articulated posteriorly with the gula (fig. 3 *n*). Sometimes an intermediate portion occurs the submentum (fig. 3 *m*); at others this is consolidated with the occiput (fig. 2 *m*). The most anterior portion is the ligula (figs. 2, 3 *i*), which is frequently notched or lobed, and is sometimes furnished with two lateral portions called paraglossæ (fig. 2*). Between the ligula and the mentum or submentum are the palpigers, one on each side (fig. 2 *i*); these are sometimes united, and to them the labial palpi (figs. 2, 3 *k*) are attached. Below the labrum are the mandibles, one on each side, forming two strong curved jaws, and frequently furnished with powerful teeth (figs. 3 *f*, 22 *b*); these are the proper organs of manducation. Below the mandibles are two other lateral organs, the maxillæ (figs. 1, 2, 3 *g*; fig. 22 *c*); they are usually less firm than the mandibles, and serve to hold and convey the food to the back of the mouth. Each maxilla is furnished with a

jointed palp (figs. 1, 2, 3 *h*), and sometimes with an appendage called the galea or helmet (fig. 22 *), and an inner curved and acute portion termed the lacinia or blade (fig. 22 †). In some insects there is a distinct soft and projecting organ, forming the floor of the mouth, the lingua or proper tongue (fig. 22 *d*); the tongue of the cricket (fig. 23) is a favourite and beautiful microscopic object.

These structures are best examined in the Coleoptera or Orthoptera, in which most of these parts are distinct. In the other orders they are altered in structure to adapt them to the nature of their food.

Thus in the Lepidoptera, the labrum and mandibles are reduced to three minute triangular plates; the maxillæ are elongated to form the *antlia* (ANTLIA), at the base of which a pair of minute palpi are often to be detected. The labium is small, triangular, and furnished with a pair of large palpi clothed with long hairs or scales, and serving for the defence of the antlia.

In the Hemiptera (Pl. 33. figs. 26, 27), the labrum is short and pointed, and overlaps the root of the rostrum; the mandibles and maxillæ are transformed into slender lancet-like organs (the maxillary palpi being obsolete), enclosed within the equally elongated horny and jointed rostrum or labium, the labial palpi also being obsolete.

In the Diptera (Pl. 33. figs. 29, 30), the five upper organs, together with the internal tongue, are elongated into lancet-like organs, the maxillary palpi being attached to the base of the maxillæ. These six organs are enclosed in a fleshy thickened piece, the labium, often terminated by two large lobes which act as suckers. In many species, however, some of these lancet-like organs are obsolete. This kind of mouth is termed a *proboscis*.

These varieties are further noticed under the heads of the genera selected for illustration.

Behind the head is the *thorax*. This consists of three rings or pieces, each of which supports a pair of legs (fig. 361 *e*, *g*, *k*). The first ring is called the prothorax (*e*), the second the mesothorax (*g*), and the third the metathorax (*k*). Each of these rings consists of a dorsal and a sternal piece; the dorsal half-rings are called the pronotum, mesonotum, and metanotum; the ventral or sternal the prosternum, mesosternum, and metasternum. In the four-winged insects, the anterior wings are attached to the central piece or mesothorax (*g*), the posterior wings to the metathorax (*k*). In the Diptera, the wings are attached to the mesothorax, and the halteres to the metathorax. Various other subdivisions have been made of these parts, but they are too numerous to mention here. It may be remarked, however, that the epimera are the pieces to which the basal joints of the legs are directly attached; that the under part of the thorax or pectus is sometimes furnished with an elongated acuminate appendage, the sternum; and that the scutellum or shield is a piece existing at the upper and back part of the mesonotum, and extending between the wings.

The *legs* (usually called feet) are placed on the underside of the body, and are joined to its segments at an articular cavity existing between the sternum and the epimeron, called the acetabulum. Each leg usually consists of five parts. The first is the hip or coxa (Pl. 35. fig. 9 *g*); but sometimes there is a small very moveable piece between the epimeron and the coxa (Pl. 35. fig. 9, between *f* and *g*), called the trochantin; this, however, is generally absent or consolidated with the coxa. The second joint is the trochanter (Pl. 35. fig. 9 *h*); it is mostly small, and annular. The third is the thigh or femur (fig. 361 *m*; Pl. 34. figs. 4, 5, 7 *d*), the thickest and usually the largest joint of the leg. Next comes the fourth, the tibia (fig. 361 *o*; Pl. 34. figs. 4, 5, 6, 7 *c*), which is thinner, usually compressed, and frequently furnished with spines, spurs, or other appendages, especially at its end; in the ant the tibiæ have each a beautiful pectinate process. The last portion is the foot or tarsus (fig. 361 *p*; Pl. 34. figs. 6, 7 *a*), which consists of several joints arranged in a row. The number of these joints varies in different insects; sometimes it is different in the anterior and posterior pairs of legs; they are, however, most commonly five. The last joint of the tarsus is usually furnished with appendages, in the form of hooks or claws, mostly two, and frequently serrated, especially near the base. Sometimes also it has two or three delicate membranous or fleshy cushions, called pulvilli (Pl. 34. figs. 7 & 8); these are more or less covered with hairs, which are sometimes terminated by little disks (fig. 9), and by which it is supposed that the insects are enabled to ascend or adhere to polished surfaces in opposition to gravity. In other insects elegant brush-like appendages are

met with in the same situation. Disks of the same kind but larger, and peculiarly-arranged hairs, sometimes occur upon the upper joints of the tarsus (Pl. 34. fig. 6, DYTISCUS; and fig. 4 *a*, APIS).

The structure of the legs of insects in the larval state (Pl. 34. figs. 32, 33) differs considerably from that of the imago as described above.

The *wings* are dry, membranous, and transparent organs, consisting of two layers, which are confluent at the margins, and are folds of the integument. Between them run canals, commonly called veins, nerves, or nervures, which are more or less numerous and ramified; and upon their arrangement the distinguishing characters of the genera &c. are sometimes founded (WINGS). The veins are formed by two wide horny half-canals in the upper and under plates, of which the wings consist. The main veins arise from the point of attachment of the wings to the thorax, and gradually diminish in diameter until they reach the extremity of the wings. The veins convey the circulating liquid, and contain each a tracheal branch, which communicates with the tracheæ of the thorax. Each nervure contains a trachea; and the blood circulates around it. In flight they are said to be distended and the wings kept expanded, by air from the interior of the body. In some kinds of wings the circulating currents are not confined to narrow channels as in the veins, but traverse a large part of the breadth of the wings (COCCINELLA).

Most insects have four wings; but in some the males only are furnished with these appendages. In the Diptera, the posterior pair of wings are rudimentary, being replaced by two little club-shaped bodies, called the *halteres*, poisers, or balancers. In this order also, and in some insects belonging to other orders, a pair of small and rounded membranous or scaly appendages are attached to the back of the base of the first pair of wings, called in the former the squamæ halterum, and in others, alulæ or winglets. In some insects, as in the beetles (Coleoptera), the anterior pair of wings are hard, horny, and opaque, forming wing-covers or ELYTRA (fig. 362), from the presence of a horny layer; and the lower wings, which are usually larger, are folded together beneath them, when at rest. In others, the posterior wings disappear, and the elytra coalesce at their inner margins. Sometimes the anterior wings are horny or leathery at the base, and membranous towards the summit (fig. 363); these are called hemelytra. At others, all the wings are thin, membranous, and transparent, as in the *Hymenoptera* and *Neuroptera*.

In the Lepidoptera, they are covered with beautiful feathers or SCALES.

There are also other modifications of the wings of certain insects, adapting them for special functions. In the Orthoptera these modifications are the agents producing the well-known chirping sounds, as in the male cricket and grasshopper. In the common house-cricket, *Acheta domestica*, each of the upper wings or elytra exhibits a clear space near the centre (Pl. 34. fig. 10 *a*), traversed by a single vein only, or at least by a very few veins. This space has received the name of the drum or tympanum. Bounding it externally is a large dark longitudinal vein, provided with three or four elevated longitudinal ridges. Immediately in front of the tympanum, near the base of the elytra, is a transverse horny ridge, tapering outwards and furnished with numerous short transverse ridges or teeth, and forming a kind of file or bow (Pl. 34. fig. 10 *b*). When the two elytra are rubbed across each other, the bow being drawn across the ridges gives rise to the peculiar sound, the intensity of which is increased by the tympanum acting as a sounding-board. The apparatus of the grasshopper is essentially of the same structure. It must be stated, however, that various other explanations of the origin of the stridulating noise produced by these insects have been given. Thus by some authors the two bows are stated to work across each other, whilst by others the legs are supposed to act against the bow. This subject possesses interest for future observation.

In other insects, there is a peculiar mechanism for uniting the anterior and posterior wings of each side, so that they may be kept steady and may act in unison during flight. In the Lepidoptera, the moths only are provided with a minute hook arising from the base of the costal nerve of the lower wing, and inserted into a socket near the base of the main nerve, on the underside of the upper wing. In the Hymenoptera, there are many such hooks arranged along part of the costal nerve at the anterior and upper margin of the second pair of wings (Pl. 34. fig. 13). When the wings are expanded, these attach themselves to a little fold on the posterior margin of the anterior wing (fig. 11 *n*), along which they play freely

when the wings are in motion, sliding to and fro like the rings on the rod of a window-curtain. These hooks are somewhat twisted towards their free end, recurved and sometimes notched at the point. They vary in number in different genera and even in the sexes. In the Hemiptera the whole margin of part of the anterior wing is hooked over a corresponding recurved part of the posterior, so as to produce the same effect.

The halteres of the Diptera and the elytra of beetles present in certain parts a multitude of vesicular projections of the external membrane; and a nervous filament passes to each. Hicks considers them to be organs of smelling.

The *abdomen* (fig. 361 *n*) forms the third and terminal portion of the body of insects. It usually consists of nine or ten rings or joints, the posterior of which, however, are sometimes so concealed, so small or so fused with the others, that they appear to be absent. The last segment of the abdomen of many insects in the females, is furnished with five or six valves or setæ, some of which form stings, saws, or borers, according to the function they perform as weapons of defence, or to cut through the tissues of plants or animals, so that the eggs may be deposited in them. The saws are well-known interesting objects. See CHALCIDIDÆ, CYNIPIDÆ, and STINGS. The abdomen contains the principal part of the alimentary canal and its appendages, with the organs of reproduction.

The *alimentary canal* varies in length in different insects, and even in the same insect at various periods of its development. It consists of the following parts:—1. The œsophagus (Pl. 35. fig. 2 *b*), a muscular organ extending through the thorax; it is sometimes dilated to form a crop or ingluvies, as in the Lepidoptera, Hymenoptera, and Diptera; and this occasionally forms a lateral sac, connected with the œsophagus by a narrower portion only, and called a sucking stomach. 2. Next follows the muscular stomach, proventriculus or gizzard (fig. 2 *c*), which is distinguished by the frequently great development of its lining membrane into plates, teeth, or hooks of horny tissue (Pl. 34. fig. 1); these serve to triturate the food, and have long been known as beautiful microscopic objects. 3. This is succeeded by a long cylindrical true stomach or ventriculus (*d*), in which digestion takes place. 4. Behind this is a longer or shorter small intestine (Pl. 35. fig. 2, between *d* and *f*), terminating in 5, a dilated portion, forming a large intestine or colon; behind which is a short rectum. The structure and length of the parts of the alimentary canal vary generally according to the nature of the food, although this is not always the case in regard to the latter.

The alimentary canal is covered by an outer homogeneous peritoneal layer; beneath which is a muscular coat, consisting of longitudinal and transverse fibres. Internally it is lined by a homogeneous epithelial layer, consisting, in part at least, of chitine. Between the latter and the muscular coat, at the middle of the alimentary canal, is a layer of cells, which probably perform a glandular function. The large intestine or colon of most insects in the imago state contains from four to six peculiar organs of doubtful nature, arranged in pairs, either transversely or longitudinally. These consist of transparent rounded, oval, or elongated tubercles, projecting inside the colon, sometimes with a horny ring at the base, and traversed by tufts of tracheæ. These organs are most numerous in the Lepidoptera. They are never found in insects in the larva- or pupa-state.

In most insects, salivary glands are present as one, two, or rarely three pairs of colourless sacs or tubes of very variable form and length, sometimes scarcely extending beyond the prothorax, at others accompanying the alimentary canal into the abdomen. They consist of an outer homogeneous envelope, lined with colourless nucleated cells, and frequently have one or more distinct ducts, sometimes containing a spiral fibre; they terminate near the mouth, in some insects the ducts previously expanding into a reservoir.

A distinct liver is not present in insects, its function being performed by the glandular cells in the walls of the true stomach. In many insects, cæcal appendages arise from the latter, and also contain cells which secrete a biliary liquid.

In some insects the small intestine is furnished with glandular appendages in the form of tubular cæca, probably representing a pancreas.

Intimately connected with the digestive and assimilative process is a curious organ called the fatty body. This attains its maximum of development towards the end of the larval period of existence. It consists of a number of fat-cells imbedded in a reticular or lamellar tissue (Pl. 35. fig. 28), composed

of a number of somewhat angular lobes connected by narrow processes having interspaces between them. These are originally formed from rounded nucleated cells, which have given off anastomosing processes (fig. 29). It is traversed by a number of slender tracheæ, and occupies the interspaces of the various abdominal organs. Each lobe consists of an outer structureless membrane, enclosing the fatty matter imbedded in an amorphous or granular substance. It appears to form a reservoir of nourishment for the insect during the pupa-state.

In most insects are found several slender and elongated, mostly simple, tubular glands, opening by simple or united ducts into that end of the true stomach corresponding to the pylorus (Pl. 35. fig. 2 *e*). Their free ends are either cæcal or unite with each other. They are often very long, and much convoluted around the intestines, sometimes presenting a varicose appearance, and dilated near their termination. These are the Malpighian vessels; and they probably perform the function of a kidney, uric acid having been found in them. They are usually yellowish or brownish, and consist of a homogeneous outer coat lined with epithelial cells. Some authors, however, consider that the renal organ is represented by one or more long vessels convoluted upon the colon and opening close to the anus; and we have found in the caterpillar of the fox moth, *Lasiocampa rubi*, numerous long convoluted tubes, of a milk-white colour, filled with octahedra and prisms of oxalate of lime; these terminated in the rectum close to the anus by very slender ducts, whilst at the upper ends, which reached to about the anterior third of the body, they were coiled upon themselves, or united with each other.

Other glandular or secreting organs also occur in insects. Thus organs corresponding to the cutaneous glands of the Vertebrata are often met with as rounded glandular cysts diffused beneath the integument, and called glandulæ odoriferæ; they open at the junction of the segments of the body, or at the joints of the legs, by very short ducts, and pour out a strongly-smelling secretion. Spaulding describes in the mentum of the bee, a spiral duct connected with certain glands situated in the thorax. In other insects, similar organs are concealed at the posterior end of the body, and pour out their secretion near the anus. Among the Hymenoptera, the females are often furnished with a glandular apparatus which secretes the poison of the Sting.

Spinning organs. A large number of those insects which undergo perfect metamorphosis are furnished in the larval state with spinning organs, with the secretion of which many larvæ, before entering the pupa-state, weave a cocoon or enclose a cavity in which to pass their period of rest, while others use this secretion for agglutinating foreign bodies to serve the same purpose. The glands secreting the silk consist of two long, tubular cæca (Pl. 34. fig. 16), which in a more or less coiled state occupy the sides of the body, and terminate anteriorly in two narrow excretory ducts, dilated to form a reservoir, and the common orifice of which opens outside the mouth on a short tubercle beneath the labium. The caterpillar is able to compress the silken threads by the contraction of an angle formed by the two capillary tubes at their point of union, and is thus enabled to suspend itself by the threads. The material of the silk is always colourless, and derives the colour which it presents in certain instances from a varnish secreted in the reservoirs, and issuing along with the former.

The *heart* in insects exists as a long contractile dorsal vessel, constricted at intervals. This terminates posteriorly in a blind end, and is narrower in front. The posterior portion performs the functions of a heart, whilst the anterior represents an aorta, and conveys the blood from the heart to the body. From the mouth of the aorta the blood passes without any vascular walls, in regular currents taking all directions, and running into the antennæ, the extremities, the wings, and other appendages, returning as a venous current. The blood finally forms two principal lateral currents directed towards the end of the abdomen, and, accumulating in the neighbourhood of the heart, is brought by its diastole through the lateral valvular tissues existing in it, whence it is again driven through the aorta as before. The walls of the dorsal vessel consist of longitudinal and transverse fibres, surrounded externally by a very delicate peritoneal layer. The cavity of the heart is lined by another delicate membrane, which in the constricted parts forms internal valvular projections, whereby the dorsal vessel is divided into as many chambers as there are constrictions. Each of these cardiac chambers is furnished at its front end, right and left, with a fissure which can be closed

internally by a valvular membranous fold. The cardiac chambers contract in regular succession from behind forwards, and thus, with the aid of the valvular apparatus, which prevents the lateral exit of the blood, propel this liquid into the aorta. This is nothing more than a continuation of the most anterior heart-chamber, and runs as a simple narrow tube beneath the back of the thorax, where it terminates either in a single aperture, or divides into several short branches, which also terminate suddenly in open orifices. The number of chambers varies; but very frequently there are eight.

In the antennæ, legs, and other appendages of the body of insects, the arterial and venous currents may be seen running together, whilst in the wings the currents are distinct.

Minute capillaries have been detected very generally diffused.

The blood of insects usually consists of a colourless liquid containing rounded or oval, colourless, nucleated corpuscles (Pl. 49. fig. 33); but sometimes it is yellowish or greenish, and rarely red.

The *respiration* of insects is effected by means of TRACHEÆ, two or more large trunks of which usually traverse the body longitudinally, giving off branches which run in all directions, and communicating with the air by numerous short tubes, connected at or near the sides of the body with orifices termed SPIRACLES or stigmata. Of those insects which live in water, some have stigmatic orifices which are brought into relation with the air at the surface of the water; whilst others in the larval state respire the air mixed with the water in which they live, this process being facilitated by the presence of external branchiæ, or processes of the integument in the form of leaves, plates, or hairs, through which numerous tracheæ ramify in every direction.

The *nervous system* of insects consists essentially of a series of ganglia arranged in pairs, one for each segment of the body, and situated between the alimentary canal and the under surface of the body. The ganglia of each pair are mostly united with each other, but sometimes distinct, and are connected with those adjacent by longitudinal cords. The uppermost pair of ventral ganglia are connected by two lateral cords surrounding the œsophagus with a large cephalic ganglion or brain. From the ganglia branches are distributed to all parts of the body. A sympathetic system of nerves is also present.

Want of space compels us to limit the notice of the reproductive organs to the description of Pl. 34. figs. 18 & 19.

Many insects undergo complete metamorphosis, between the period at which they are hatched and that at which they attain their full development. On first leaving the egg, they assume a more or less worm-like form, known as the larva, caterpillar, or maggot. The next stage is that in which they usually neither move nor take food, when they form the nympha, pupa, or chrysalis. This state is succeeded by that of the perfect insect or imago. In other insects, however, among the Orthoptera, Hemiptera, and Neuroptera, the metamorphosis is incomplete, the body, legs, and antennæ of the larva being nearly similar in form to those of the imago, but the wings are wanting. In some insects, also, of the above orders, the pupa continues to be active, differing only from the larva in its larger size, and in having acquired rudimentary wings (Pl. 35. figs. 15, 17, 21).

In some insects the only change consists in ecdysis, without material alteration in structure. Parthenogenesis occurs; and some larvæ reproduce.

Examination, &c. The external parts and organs of insects are usually examined as opaque objects, the animals being held in the stage-forceps. This method, however, is often very unsatisfactory; and the best is to press them as much as possible between two slides, without crushing, and to fasten the slides together with india-rubber bands or fine string, so that the parts may dry in the compressed form. When subsequently soaked in oil of turpentine, and mounted in balsam, they will become much more transparent and distinct. By prolonged maceration in turpentine, the whole of the pigment may be removed, which causes the structure to be seen very distinctly. When the organs are very hard and thick, they may be softened by boiling water, or solution of potash, before being pressed between the slides.

The internal organs, which are very delicate, must be brought to view by dissection under water, the insects being fixed by pins stuck into the leaded cork (INTRODUCTION, p. xxvii).

The smaller and more delicate insects, aquatic larvæ, &c. are best preserved in solution of chloride of calcium or glycerine, mounted in suitable glass cells.

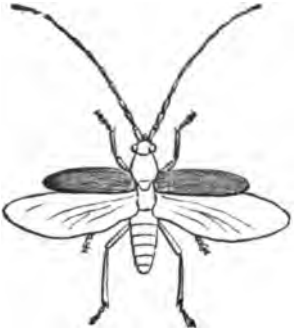
To preserve insects for the future examination of the internal structure, they should be kept in solution of chloride of zinc; but

when very soft and fragile, they may be kept in spirit and water.

Insects are divided into eleven orders, thus:—

Ord. 1. *Coleoptera* (Beetles). Wings four, anterior hard, coriaceous or horny (elytra), covering the posterior, which are membranous and transversely folded; mouth formed for manducation, furnished with mandibles, maxillæ, and palpi, both labial and maxillary; metamorphosis complete (fig. 362).

Fig. 362.



Cerambyx sedilis.
Nat. size.

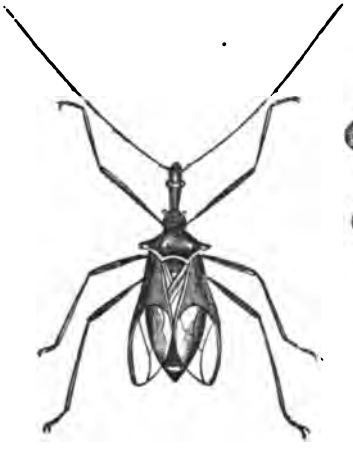
Ord. 2. *Orthoptera* (Grasshoppers, Crickets, &c.). Wings four, the upper coriaceous, veiny, the inferior membranous, longitudinally plaited like a fan; mouth serving for manducation, with strong mandibles; maxillæ furnished with a cylindrical helmet; metamorphosis incomplete.

Ord. 3. *Hemiptera* (Bugs, &c.). Wings four, all membranous, or the anterior ones coriaceous at the base, and thicker; mouth with a jointed rostrum (labium), ensheathing setæ (mandibles and maxillæ); palpi none; metamorphosis with few exceptions incomplete (fig. 363).

Ord. 4. *Neuroptera* (Lace-wings, Dragonflies, &c.). Wings four, membranous, generally pellucid, reticulated, naked, very often equal; mouth not suctorial, but mostly made for manducation; mandibles in some obsolete; females never furnished with a sting, and but rarely with a borer or exserted oviduct; metamorphosis mostly incomplete, in some complete (fig. 364).

Ord. 5. *Lepidoptera* (Butterflies, Moths). Wings four, membranous, covered with coloured scales; mouth furnished with an involute, spiral tongue, composed of

Fig. 363.



Reduvius tuberculatus.
Nat. size.

Fig. 364.

Libellula depressa.
Nat. size.

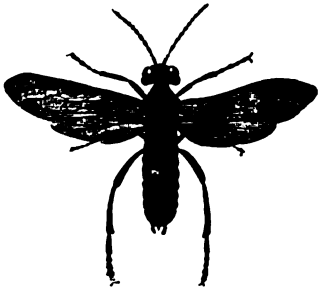
the elongated maxillæ; metamorphosis complete (fig. 365).

Fig. 365.

Danais Plexippe.
Nat. size.

Ord. 6. *Hymenoptera* (Bees, Wasps, &c.). Wings four, membranous, posterior ones smaller, and with fewer veins; maxillæ elongate, generally slender, sheathing the

Fig. 366.



Tenthredo nassata.
Magnified 2 diameters.

labium; abdomen of the females almost always terminated by an ovipositor or a sting; metamorphosis complete (fig. 366).

Ord. 7. *Diptera* (Flies). Wings two, with alulets at the base; two halteres; mouth suctorial; labium not furnished with palpi, prolonged into a proboscis or sheath, and enclosing setæ variable in number; maxillary palpi two, at the base of the proboscis; metamorphosis complete.

Ord. 8. *Strepsiptera* or *Rhipiptera*. Males with four wings; anterior wings two small moveable corpuscles; posterior wings large, membranous, in the form of a quadrant of a circle, longitudinally folded like a fan. Females apterous, vermiform, without legs. Metamorphosis complicated; mandibles two, narrow, somewhat curved; palpi two, biarticulate, far apart, inserted beneath the head (larvæ, pupæ, and females living parasitically in Hymenopterous insects).

Ord. 9. *Suctoria* or *Siphonaptera* (Fleas). Wingless; metamorphosis complete; mouth suctorial; rostrum composed of two serrated laminæ and a thin suctorial seta, included in a jointed two-valved sheath.

Ord. 10. *Anoplura* or *Parasitica* (Lice, Pl. 35. figs. 3–8). Wings absent; not undergoing metamorphosis; parasitic (eyes two, simple, sometimes none).

Ord. 11. *Thysanura*. Wings absent; not undergoing metamorphosis; not parasitic; mouth furnished with mandibles and maxillæ; eyes simple, in two groups; abdomen mostly terminated by setæ or a bifid tail.

Bibl. Newport, *Todd's Cycl. An. and Phys.* art. *Insects*; Kirby and Spence, *Intr. Entom.*; Burmeister, *Entom.*; Newman, *Insects*; Siebold, *Vergl. Anat.*; Straus-Durckheim, *Cons. gén. s. l'Anat. d. Anim. articul.*; Westwood, *Introd.*; id. *Butterflies of Great Britain*; Stephens, *Brit. Beetles*, and *Br. Entom.*; Spry and Shuckard, *Br. Coleopt.*; Kirby, *Mon. Apum*; Curtis, *Br. Entom.*; Panzer, *Deutsch. Insekt.*; Walker, *Insecta Brit.*; Fabre, *Ann. Sc. Nat.* sér. 4. vii.; Ganin, *Zeitschr. wiss. Zool.* 1869; Kowalevsky, *Mém. l'Acad. St. Pétersb.* xvi. 1871; Douglas and Scott, *Hemip. Heter., Ray Soc.*; Schultze, *Q. M. Jn.* 1868; Landois, *Schultze's Archiv*, 1867; Lyonet, *Ann. Sc. Nat.* sér. 2. t. v.; Ratzeburg, *Forst-Insekt.* 1844; Lacaze-Duthiers, *Ann. Sc. Nat.* sér. 3. t. xix.; Gerstaecker, *Klass. und Ordnung.*; Weismann, *Dipter.*; Herold, *Schmetterl.*; Metschnikow, *Zeit. wiss. Zool.* B. xvi.; Leydig, *Hist.*; Gegenbauer, *Vergl. Anat.* 1878; Scudder, *Tr. Smith. Inst.*; Hicks, *J. Linn. Soc.* i. 136; id. *Linn. Tr.* xxii. 141, xxiii. 189; T. West, *Linn. Tr.* xxii. 393; Hepworth, *Q. Mic. Jn.* ii. 158; Packard, *Mem. Acad.* (*Peabody*) *Entomol.*; Charpentier, *Orthopt.*; Fischer, *Orthopt. Europ.*; Wolff, *Riechorg. Biene &c.* 1875; Watney, *Jn. M. Soc.* 1877, xvii. 213; Frey, *Lepidopt. Schweiz*, 1880; Köppen, *Injurious Insects, Russia*, 1880; Brehm, *Insect.* 1881, 1500 figs.; Newman, *Br. Moths* and *Butterfl.*; Wilson, *Larvæ of Br. Lepid.*, figs.; Lowne, *Phil. Tr.* 1878, 577, *eyes*; Minot,

Arch. Phys. 1876, *tracheæ*; Adolph, *Insekt-Flügel*, 1880; Spaulding, *Amer. Nat.* 1881, xv. 113 (*Jn. M. Soc.* 1881, 442); Dritl, *Zeitschr. wiss. Zool.* 1876, xxvii., *brain*; M'Lachlan, *Enc. Brit.* 1882, xiii. 141.

INSILEL'LA, Ehr.—A genus of Diatomaceæ.

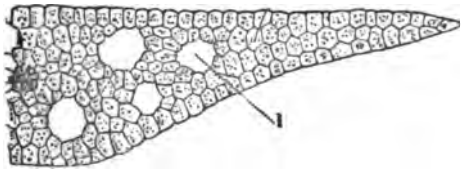
Char. Frustules single, fusiform, with a turgid ring (hoop?) interposed between the valves, which are equal; =a terete *Biddulphia*. Marine.

I. africana. Frustules with four constrictions, broader and subglobose in the middle, diminishing in size towards the acuminate ends; no markings visible by ordinary illumination; length 1-530; on the coast of Africa.

Bibl. Ehr. *Ber. Berl. Ak.* 1845, 357; Kütz. *Sp. Alg.* 32.

INTERCELLULAR Passages, Spaces, &c. of Plants.—Where the cells of vegetable tissue are of any but six- or twelve-sided forms, interspaces must exist between them. These are especially evident in parenchyma formed of rounded cells, where

Fig. 368.



Vertical section of half a leaf of a Potamogeton, with air-spaces *l*.

Magnified 200 diameters.

there exist of course, angular intercommunicating intercellular *passages*. The stomata of Leaves always communicate with such intercellular passages, larger in the lower part of the parenchyma of leaves. Intercellular spaces are lacunæ of larger size, definite or indefinite in form, bounded by a number of cells of less capacity than the space itself. These are especially large and abundant, as air-receptacles, in aquatic plants, both in the stems and leaves, as in the Nymphæaceæ, Naiadaceæ (fig. 368), and Hydrocharidaceæ, &c., but also common in most Monocotyledonous plants, such as Juncaceæ (Pl. 47. fig. 18), Araceæ, Grasses, &c.

Intercellular spaces and canals likewise serve as Receptacles for Secretions, as in the case of the glands of the Aurantiaceæ (fig. 280) (see also Glands), and the turpentine-canals of the Coniferæ. The milk-vessels of plants appear to be formed sometimes in intercellular canals, sometimes out of cells (Laticiferous Tissue).

Bibl. Works on Structural Botany.

INTERCELLULAR SUBSTANCE of Plants, or Secondary Cell-deposits.—When we make fine sections of many kinds of cellular structure, as for instance of the horny albumen of the seeds of Palms (*Areca*, Pl. 47. fig. 21) or other plants, of the collenchymatous tissue beneath the epidermis of the Chenopodiaceæ &c., of the substance of cartilaginous Algæ, of many woods, &c., we find an appearance of intervals between the lines bounding the component cells, which intervals are filled up with apparently homogeneous substance. Thus seen and no further investigated, the interposed matter was formerly described as *intercellular substance*, a peculiar form of vegetable organization; and some went so far as to imagine that cells originated free in this, and subsequently became glued together and fixed by the solidification of the whole (Unger and Endlicher). The application of dilute sulphuric acid to preparations of this kind, with iodine, generally shows clearly that the supposed intercellular substance consists of secondary deposits really inside the cells (Pl. 47. fig. 22). Recent observations go to prove that the supposed intercellular substance, a matter secreted or otherwise produced between the cells of a tissue, is of very rare occurrence, even if existing at all. Probably the appearance is produced by modification of the cell-wall. See Epidermis, Secondary deposits, Wood, and Albumen.

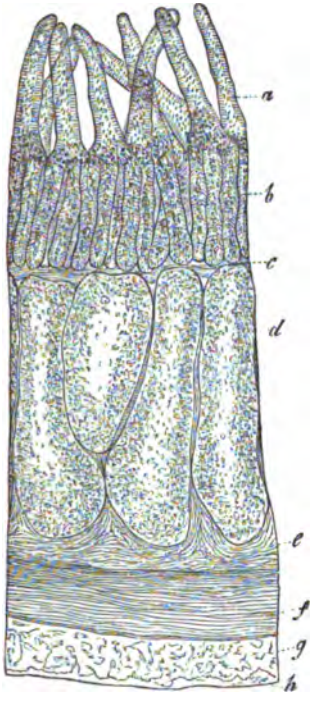
Bibl. Mohl, the Bibl. of Cell-membrane; Unger, *An. u. Phys. Pfl.* 1846, 18; Mulder and Harting, *Phys. Chem.*; Hartig, *Ann. Sc. Nat.* 2 sér. v.; Wigand, *Intercell. Subst.* 1850; Cohn, *Linnæa*, xxiii. 337, 1850; Schacht, *Pflanzenzelle*, Berlin, 1852, 76; Bentley, *Bot.*; Henfrey-Masters, *Elem. Course.*

INTESTINES.—The intestines consist of three coats: an outer, peritoneal, or serous membrane, an inner or mucous membrane, and an intermediate muscular coat.

The connective tissue of the mucous membrane is often indistinctly fibrous, especially its inner portions, where it forms the basement membrane; it contains scat-

tered, roundish, elongate nuclei, without elastic tissue. Between the proper mucous membrane and the submucous tissue, is situated a layer of longitudinal and transverse unstriped muscular fibres, frequently, however, indistinct in man.

Fig. 369.



Magnified 60 diameters.

Perpendicular section of the wall of the lower part of the ileum of the calf: *a*, villi; *b*, Lieberkühn's glands, *c*, muscular layer of the mucous membrane; *d*, follicle of a Peyer's gland; *e*, subjacent portions of the submucous tissue; *f*, circular muscular fibres; *g*, longitudinal ditto.

The epithelium of the intestines consists of a single layer of cylindrical cells, containing a transparent oval nucleus, with one or two nuclei, and granular matter.

In the small intestines, the free border of the epithelium-cells presents a broad seam with delicate longitudinal striæ, forming the so-called pore-canals. Besides the ordinary cylindrical or columnar cells are certain cup-, or goblet-shaped cells, the open mouths of which are directed towards the cavity of the intestine (Pl. 53. fig. 20). It is a question whether these goblet-cells are modified epithelium-cells, or represent peculiar morphological elements.

The surface of the small intestines is covered with Villi, which are absent in the large intestines; and in every villus one or two spaces are found, constituting the origin of the lacteals.

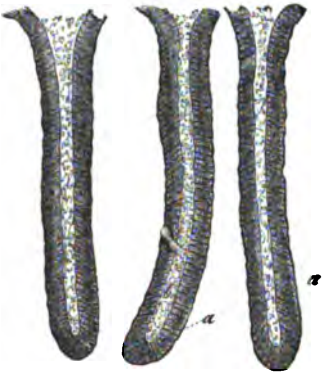
The elements of the muscular coat are unstriped muscular fibres, consisting of pale, homogeneous, fusiform, flattened cells, with an elongated nucleus. The fibres frequently present knotty expansions, and sometimes zigzag flexuosities.

The glandular organs of the small intestines consist of:—Brunner's or the racemose glands; Lieberkühn's follicles or the tubular glands; Peyer's, the aggregate or agminate glands; and the solitary glands or follicles.

Brunner's glands are situated in the submucous tissue of the duodenum, extending about as far as the orifice of the choledic duct. If a portion of the intestine be kept stretched, or distended with air, and the muscular coat be dissected off, they are seen as yellowish, flattened, roundish-angular bodies, mostly about 1-50 to 1-25″ in size, the short ducts of which pass through the mucous membrane. They secrete an alkaline mucous liquid.

Lieberkühn's follicles, or the tubular glands (fig. 370), are distributed throughout

Fig. 370.



Magnified 60 diameters.

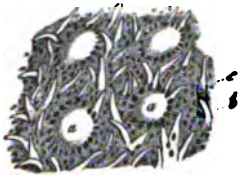
Lieberkühn's follicles, from the pig: *a*, basement membrane and epithelium; *b*, cavity.

the small intestines, extending through the substance of the mucous membrane. They are very numerous, straight, narrow, slightly dilated at the ends, and rarely bifurcate.

They vary in length from 1-60 to 1-84", and consist of a delicate basement membrane, lined with epithelium.

Peyer's glands are rounded or elongated flattened aggregations of glands, appearing

Fig. 371.



Magnified 10 diameters.

Portion of a Peyer's gland, human: *a*, follicles surrounded by the orifices of Lieberkühn's glands; *b*, villi; *c*, scattered Lieberkühn's glands.

upon the inner side of the intestine as slightly depressed spots. They are most numerous in the ileum, but are sometimes found in the lower part of the jejunum, or even its upper part and the duodenum. They are usually twenty, thirty, or more in number. They vary in length from 1-25 to 1½". Each consists of an aggregation of closed and rounded follicles, from 1-70 to

Fig. 372.

Solitary gland, covered with villi, from the jejunum.

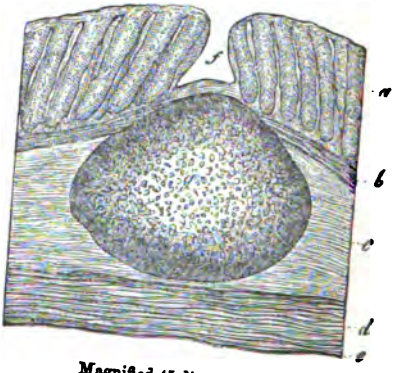
1-12" in diameter, partly seated in the mucous membrane itself, partly in the submucous tissue. The follicles are surrounded by a ring of Lieberkühn's glands, which, with villi, also occupy the intervening portion of the mucous membrane. Each follicle consists of a tolerably firm coat of indistinctly fibrous areolar tissue, with scattered nuclei, enclosing a grey soft substance consisting of innumerable nuclei and cells, from 1-3000 to 1-1500" in diameter, with a few granules of fat. The follicles are surrounded by a vascular network, which sends off branches to their interior.

The solitary glands agree in structure with the individual follicles of Peyer's glands. Their free surface is usually convex, and covered with villi (fig. 372).

The glandular organs of the large intestines are Lieberkühn's glands and the solitary follicles.

The Lieberkühn's glands agree in structure with those of the small intestines, except that they are larger and broader in proportion to the greater thickness of the mucous membrane. The solitary follicles also differ from those of the small intestine

Fig. 373.



Magnified 45 diameters.

Solitary follicle from the colon of a child: *a*, tubular glands; *b*, muscular coat of the mucous membrane; *c*, submucous tissue; *d*, transverse muscular fibres; *e*, peritoneum; *f*, depression in mucous membrane over the follicle *g*.

in their larger size, and in the circumstance that each of the minute elevations of the mucous membrane produced by them exhibits a rounded or elongated opening, leading to a depression in the mucous membrane over the follicle (fig. 373). This, however, has no communication with the follicle.

The investigation of the structure of the intestines is a matter of some difficulty. The epithelium must be examined in a perfectly fresh state. The glands are most readily seen in portions hardened by absolute alcohol or chromic acid; whilst some have recommended boiling with acetic acid (80 per cent.), then drying and making sections with a Valentin's knife. The muscular elements are rendered most distinct by maceration with dilute nitric acid (20 per cent.).

The capillaries of the intestines are very beautiful when injected; but great care is required in securing the vascular branches, to prevent the escape of the injection.

Two thick layers of ganglionic nervous masses are distinguishable in the intestines. One is situated in the submucous tissue, the other between the circular and longitudinal muscular fibres. The former is a flat layer with a few ganglia projecting towards the mucous membrane and penetrating among the follicles; the latter is more irregular, and presents nodulated ganglionic masses. The ganglia give off and are traversed by nerves that form a plexus, some joining the ganglionic layers, others uniting with the mesenteric nerves. The nerves are non-medullated.

BIBL. Kölliker, *Mikr. Anat.*; Verson, *Stricker's Hist.*; Frey, *Hist., & the full literature.*

IN'ULINE.—A substance allied to starch, occurring in solution in the cell-contents of plants, especially the Compositæ, as the *Dahlia*, dandelion, &c.; it is coloured yellow by iodine. It forms crystalloids or sphærocrystals resembling those in Pl. 39. fig. 11; and they exhibit the black cross with polarized light. In a section of a tuber of the Jerusalem artichoke, macerated in spirit, they will be found in the cells, and may be mounted in glycerine.

BIBL. Gmelin, *Chemie*, vii.; Prantl, *Inulin*, 1870; Dragendorff, *Material. &c.*, 1870; Sachs, *Bot.* 1874.

IODINE.—Solution of iodine is often useful for dyeing and rendering very transparent objects more distinct, and for its producing with some vegetable and animal tissues and substances colours by which they may be distinguished. The general results of its action are enumerated in the INTRODUCTION; and special remarks are made under the heads of the tissues.

An aqueous solution of iodine is the best for general use; but a solution in spirit is much stronger. A very strong solution may be made by dissolving iodine in a solution of iodide of potassium; this may be used for dyeing tissues, but not for the detection of cellulose, as the precipitated iodine gives a bluish tinge to the structure. Solutions of iodine in chloride of zinc, and of iodide of zinc are valuable reagents for cellulose. See SCHULTZE'S TEST.

Iodized serum is made of amniotic fluid (calf) and a small quantity of strong tincture of iodine. It has a pale yellow tint. It is used as but little altering the appearances of delicate objects.

An artificial substitute may be made with 1 oz. of white of egg, 30 grs. of salt, 8 oz. of water, enough tincture of iodine to colour, and 2 or 3 drops of carbolic acid, the whole to be well shaken and filtered.

IRIDÆ'A, Bory.—A genus of Cryptonemiaceæ (Florideous Algæ), containing one common British species, *I. edulis*, a dull-red, obovate, leaf-shaped sea-weed of fleshy-cartilaginous texture, 4-18″ long, the central substance composed of longitudinal, the cortical of closely-packed moniliform perpendicular filaments. Fructification: *spores* in spherical masses (*favellidia*), imbedded in the frond in wide patches near the extremity; *tetraspores* in dense band-like immersed sori.

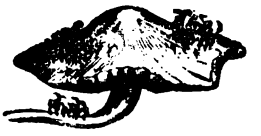
BIBL. Harvey, *Mar. Alg.* 150, pl. 19 A; *Phyc. Brit.* pl. 97; Greville, *Alg. Brit.* pl. 17; *Eng. Bot.* pl. 1307.

IRIDESCENCE. See INTRODUCTION, p. xxxv.

IRIS. See EYE, p. 311.

ISARIA, Hill.—A genus of ISARIACEI (reputed Hyphomycetous Fungi), growing upon dead insects, fungi, or twigs or leaves of plants. *I. farinosa*, Fries, grows to a height of 1-2″ on dead pupæ, spiders' nests, &c. *I. arachnophila*, Ditton, *intricata*, Fr., *puberula*, Berk., and *Friesii*, Montagne, are also British. *I. citrina* (figs. 374, 375) is a

Fig. 374.



Isaria citrina. Plants on a fungus. Natural size.

small species, growing gregariously on vegetable substances.

Tulasne has recently published an interesting paper on *Isaria*, showing that at any rate some of the forms referred to this genus are conidiiferous fruits of certain *Sphæriæ*—in particular that *Is. crassa* (*farinosa*, Fr.) is a form of *Sphæria militaris*. This plant is found most frequently on the larvæ of *Bombyx Rubi*; and the first sign of its growth is the formation of a mildew, between the rings of the abdomen, very much resembling a *Botrytis*. Subsequently the body of the larva, quite filled up and rigid with mycelial

Arch. Phys. 1876, *tracheæ*; Adolph, *Insekt-Flügel*, 1880; Spaulding, *Amer. Nat.* 1881, xv. 113 (*Jn. M. Soc.* 1881, 442); Dritl, *Zeitschr. wiss. Zool.* 1876, xxvii., *brain*; M'Lachlan, *Enc. Brit.* 1882, xiii. 141.

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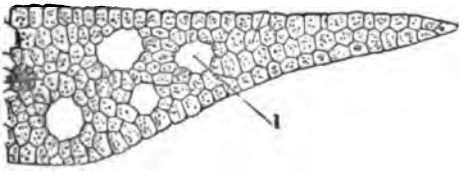
I. africana. Frustules with four constrictions, broader and subglobose in the middle, diminishing in size towards the acuminate ends; no markings visible by ordinary illumination; length 1-530; on the coast of Africa.

BIBL. Ehr. *Ber. Berl. Ak.* 1845, 357; Kütz. *Sp. Alg.* 32.

INTERCELLULAR PASSAGES, SPACES, &c. OF PLANTS.—Where the cells of vegetable tissue are of any but six- or twelve-sided forms, interspaces must exist between them. These are especially evident in parenchyma formed of rounded cells, where

Fig. 368.



Vertical section of half a leaf of a Potamogeton, with air-spaces *l*.

Magnified 200 diameters.

there exist of course, angular intercommunicating intercellular *passages*. The stomata of LEAVES always communicate with such intercellular passages, larger in the lower part of the parenchyma of leaves. Intercellular spaces are lacunæ of larger size, definite or indefinite in form, bounded by a number of cells of less capacity than the space itself. These are especially large and abundant, as air-receptacles, in aquatic plants, both in the stems and leaves, as in the Nymphæaceæ, Naiadaceæ (fig. 368), and Hydrocharidaceæ, &c., but also common in most Monocotyledonous plants, such as Juncaceæ (Pl. 47. fig. 18), Araceæ, Cyperaceæ, &c.

Intercellular spaces and canals likewise serve as RECEPTACLES for SECRETIONS, as in the case of the glands of the Aurantiaceæ (fig. 280) (see also GLANDS), and the turpentine-canals of the Coniferæ. The milk-vessels of plants appear to be formed sometimes in intercellular canals, sometimes out of cells (LATICIFEROUS TISSUE).

BIBL. Works on Structural Botany.

INTERCELLULAR SUBSTANCE OF PLANTS, OR SECONDARY CELL-DEPOSITS.—When we make fine sections of many kinds of cellular structure, as for instance of the horny albumen of the seeds of Palms (*Areca*, Pl. 47. fig. 21) or other plants, of the collenchymatous tissue beneath the epidermis of the Chenopodiaceæ &c., of the substance of cartilaginous Algæ, of many woods, &c., we find an appearance of intervals between the lines bounding the component cells, which intervals are filled up with apparently homogeneous substance. Thus seen and no further investigated, the interposed matter was formerly described as *intercellular substance*, a peculiar form of vegetable organization; and some went so far as to imagine that cells originated free in this, and subsequently became glued together and fixed by the solidification of the whole (Unger and Endlicher). The application of dilute sulphuric acid to preparations of this kind, with iodine, generally shows clearly that the supposed intercellular substance consists of secondary deposits really inside the cells (Pl. 47. fig. 22). Recent observations go to prove that the supposed intercellular substance, a matter secreted or otherwise produced between the cells of a tissue, is of very rare occurrence, even if existing at all. Probably the appearance is produced by modification of the cell-wall. See EPIDERMIS, SECONDARY DEPOSITS, WOOD, and ALBUMEN.

BIBL. Mohl, the BIBL. of CELL-MEMBRANE; Unger, *An. u. Phys. Pfl.* 1846, 18; Mulder and Harting, *Phys. Chem.*; Hartig, *Ann. Sc. Nat.* 2 sér. v.; Wigand, *Intercell. Subst.* 1850; Cohn, *Linnæa*, xxiii. 337, 1850; Schacht, *Pflanzenzelle*, Berlin, 1852, 76; Bentley, *Bot.*; Henfrey-Masters, *Elem. Course.*

INTESTINES.—The intestines consist of three coats: an outer, peritoneal, or serous membrane, an inner or mucous membrane, and an intermediate muscular coat.

The connective tissue of the mucous membrane is often indistinctly fibrous, especially its inner portions, where it forms the basement membrane; it contains scat-

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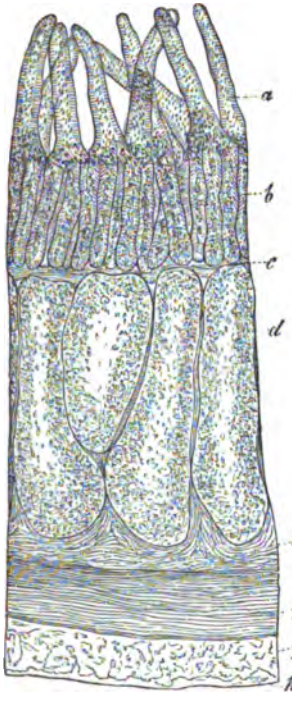
Fig. 369.



Magnified 60 diameters.

Perpendicular section of the wall of the lower part of the ileum of the calf: *a*, villi; *b*, Lieberkühn's glands, *c*, muscular layer of the mucous membrane; *d*, follicle of a Peyer's gland; *e*, subjacent portions of the submucous tissue; *f*, circular muscular fibres; *g*, longitudinal ditto.

The epithelium of the intestines consists of a single layer of cylindrical cells, containing a transparent oval nucleus, with one or two nuclei, and granular matter.

In the small intestines, the free border of the epithelium-cells presents a broad seam with delicate longitudinal striæ, forming the so-called pore-canals. Besides the ordinary cylindrical or columnar cells are certain cup-, or goblet-shaped cells, the open mouths of which are directed towards the cavity of the intestine (Pl. 53. fig. 20). It is a question whether these goblet-cells are modified epithelium-cells, or represent peculiar morphological elements.

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The glandular organs of the small intestines consist of:—Brunner's or the racemose glands; Lieberkühn's follicles or the tubular glands; Peyer's, the aggregate or agminate glands; and the solitary glands or follicles.

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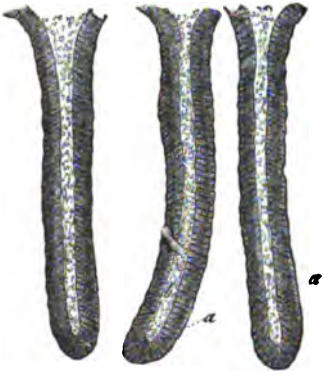
Lieberkühn's follicles, or the tubular glands (fig. 370), are distributed throughout

Fig. 370.



Magnified 60 diameters.

Lieberkühn's follicles, from the pig: *a*, basement membrane and epithelium; *b*, cavity.

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Arch. Phys. 1876, *tracheæ*; Adolph, *Insekt-Flügel*, 1880; Spaulding, *Amer. Nat.* 1881, xv. 113 (*Jn. M. Soc.* 1881, 442); Dritl, *Zeitschr. wiss. Zool.* 1876, xxvii., *brain*; M'Lachlan, *Enc. Brit.* 1882, xiii. 141.

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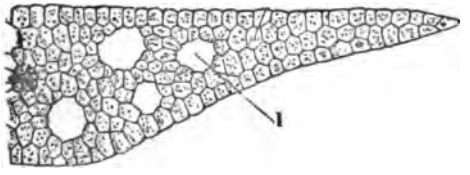

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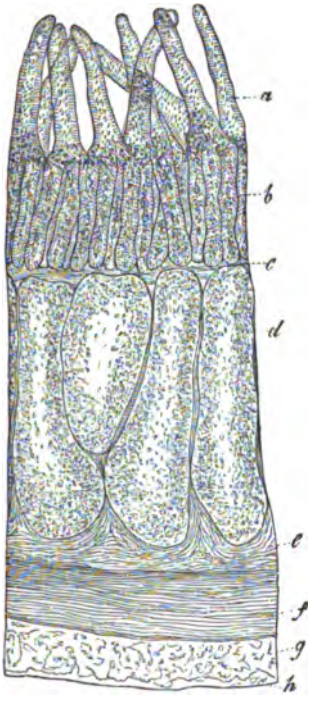
Fig. 369.



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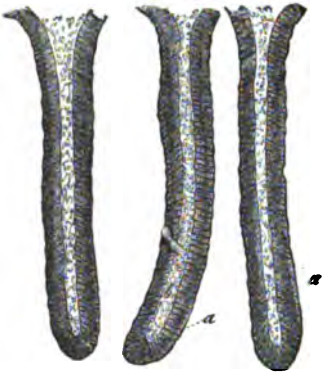

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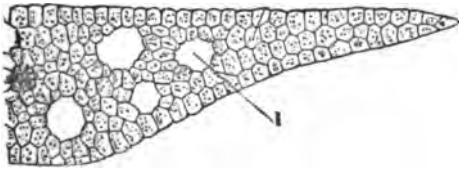

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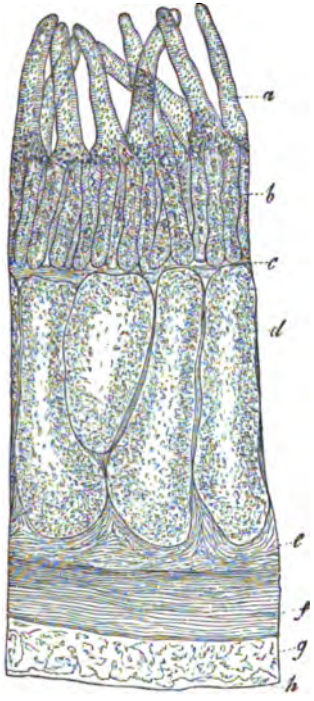

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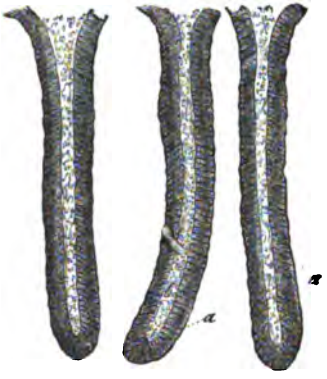

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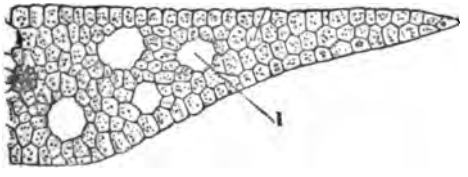

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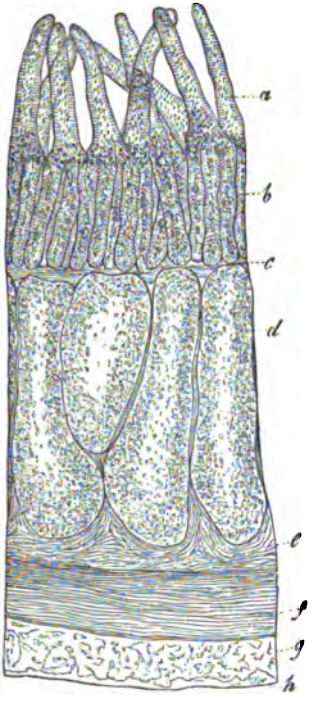

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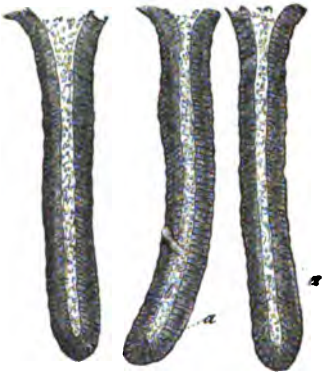

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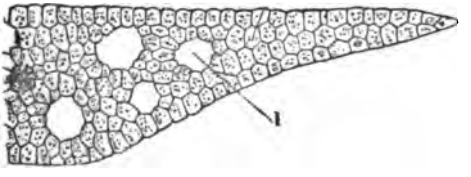

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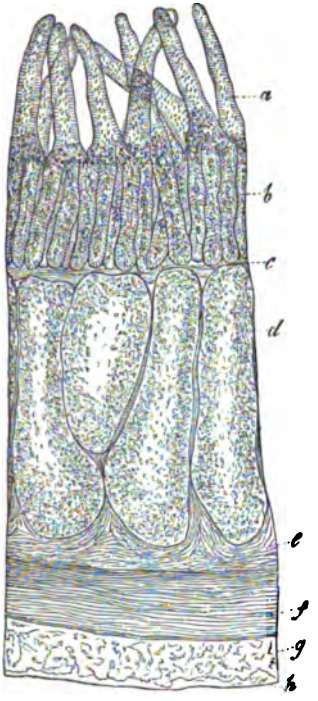

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Perpendicular section of the wall of the lower part of the ileum of the calf: *a*, villi; *b*, Lieberkühn's glands, *c*, muscular layer of the mucous membrane; *d*, follicle of a Peyer's gland; *e*, subjacent portions of the submucous tissue; *f*, circular muscular fibres; *g*, longitudinal ditto.

The epithelium of the intestines consists of a single layer of cylindrical cells, containing a transparent oval nucleus, with one or two nuclei, and granular matter.

In the small intestines, the free border of the epithelium-cells presents a broad seam with delicate longitudinal striæ, forming the so-called pore-canals. Besides the ordinary cylindrical or columnar cells are certain cup-, or goblet-shaped cells, the open mouths of which are directed towards the cavity of the intestine (Pl. 53. fig. 20). It is a question whether these goblet-cells are modified epithelium-cells, or represent peculiar morphological elements.

The surface of the small intestines is covered with VILLI, which are absent in the large intestines; and in every villus one or two spaces are found, constituting the origin of the lacteals.

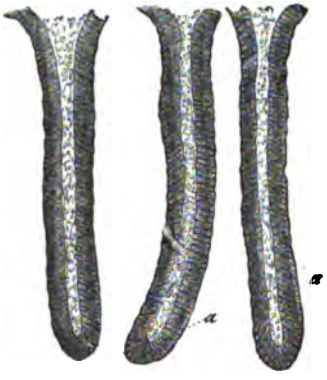
The elements of the muscular coat are unstriped muscular fibres, consisting of pale, homogeneous, fusiform, flattened cells, with an elongated nucleus. The fibres frequently present knotty expansions, and sometimes zigzag flexuosities.

The glandular organs of the small intestines consist of:—Brunner's or the racemose glands; Lieberkühn's follicles or the tubular glands; Peyer's, the aggregate or agminate glands; and the solitary glands or follicles.

Brunner's glands are situated in the submucous tissue of the duodenum, extending about as far as the orifice of the choledic duct. If a portion of the intestine be kept stretched, or distended with air, and the muscular coat be dissected off, they are seen as yellowish, flattened, roundish-angular bodies, mostly about 1-50 to 1-25″ in size, the short ducts of which pass through the mucous membrane. They secrete an alkaline mucous liquid.

Lieberkühn's follicles, or the tubular glands (fig. 370), are distributed throughout

Fig. 370.



Magnified 60 diameters.

Lieberkühn's follicles, from the pig: *a*, basement membrane and epithelium; *b*, cavity.

the small intestines, extending through the substance of the mucous membrane. They are very numerous, straight, narrow, slightly dilated at the ends, and rarely bifurcate.

stolon; hydrothecæ tubular, sessile, or with a short pedicel; without an operculum; polypites cylindrical, with a conical proboscis. There are five British species.

BIBL. Hincks, *Brit. Zooph.* p. 198.

LAFOË'IDÆ.—A suborder of Hydroida. See LAFOËA.

LAGE'NA, Walker & Jacob.—A unilocular (rarely bilocular) hyaline Foraminifer, of the Nodosarine group, generally flask-shaped. The shell may be subglobular, oval, oblong, or fusiform; round, compressed, or angular in section; variously ornamented with ribs, network, tubercles, and spines; open at one or both ends, with or without a neck, and often with the tube turned inwards (Entosolenian). Recent and fossil all over the world. *Lagena lævis* (Pl. 23. f. 22) is a typical and very common form. *L. (Entosolenia) globosa* (f. 23), with the neck-tube introverted, is another very common variety. *L. striata* (f. 24) is an elongato-apiculate variety, delicately costulate. *L. semistriata* (f. 25) is *L. globosa* with short basal ribs. *L. squamosa* (f. 26) was so called because the early microscopes showed the pitted reticulation as raised scales. *L. scalariformis* (f. 27) has a bold hexagonal mesh ornament. The last is recent, and the others are both fossil and recent.

BIBL. Carpenter, *Introd.* 156; Parker & Jones, *Phil. Tr.* clv. 345; P., J. & Brady, *Mon. Crag Foram.* 28.

LAGENEL'LA, Ehr.—A genus of Infusoria, fam. Cryptomonadina.

L. euchlora (Pl. 31. figs. 35 & 36) has a carapace with a beak or neck like that of a bottle, and a red eye-spot; freshwater; length 1-1150″; probably an Alga-spore.

BIBL. Ehr. *Inf.* 45; Duj. *Inf.* 333.

LAGENIP'ORA, Hincks.—A genus of Cheilostomatous Polyzoa, fam. Porinidæ.

L. socialis, on shells of the scallop (*Pecten maximus*); Hastings. (Hincks, *Polyz.* 235.)

LAGENŒ'CA, Kt.—A genus of Flagellate Infusoria.

Char. Solitary, with a collar, in a protective sheath.

L. cuspidata (Pl. 53. fig. 21), amber-coloured; pond water. (Kent, *Inf.* 359.)

LAGE'NOPHRYS, Stein.—A genus of Vorticellina (Infusoria).

Char. Capsules not stalked, attached by the side to other bodies; body suspended from the narrow orifice. *L. vaginicola*, on the tail of *Cyclopsine*; 2 other species on *Gammarus*. (Stein, *Infus.* 1854.)

BIBL. Stein, *Inf.* 1854, 88; Pritchard, *Inf.* 604; Claparède et Lach. *Inf.*

LAGO'TIA, Wright, = FREIA, Wright, *Edin. Ph. Jn.* 1858.

LAGY'NIS, Schultze, = *Euglypha* pt.

LAGY'NUS, Quenn.—A genus of Holotrichous Infusoria. Free, flask-shaped, with an oral circle of longer cilia; neck ringed. *L. elegans*, freshwater. (Kent, *Inf.* 520.)

LAMINA'RIA, Lamx.—A genus of Lamina-riaceæ (Fucoid Algæ), with large, flat, stipitate fronds, several species of which are common on rocky shores, attached to rocks and stones. *L. saccharina* has a riband-shaped frond, growing from 2 to 12 feet long. *L. digitata* has a broad frond, 1 to 5 feet long, cut into a variable number of segments. The internal structure presents three layers, the outermost forming a kind of epidermis. The *sporanges* (spores of authors) contain ciliated zoospores which reproduce the plant. They are little elongated sacs, nestling between epidermal cells of peculiar structure, standing perpendicularly upon the central substance of the frond. In *L. saccharina* the presence of the sporanges is denoted by a longitudinal brown mark in the centre of the frond; in *L. digitata* they occur in flat patches on the extremities of the digitations. The zoospores are little olive-coloured bodies, with an anterior and posterior cilium. Thuret has seen them germinate.

BIBL. Harvey, *Mar. Alg.* 29, pl. 4; *Phyc. Br.* pl. 192, 223, 241; Greville, *Alg. Brit.* t. 5; Thuret, *Ann. Sc. Nat.* 2 sér. xiv. 240, pl. 30. figs. 1-4; Henfrey-Masters, *Bot.*

LAMINARIA'CEÆ.—A family of Fucoideæ. Olive-coloured inarticulate seaweeds, whose sporanges are superficial, either forming indefinite cloud-like patches, or covering the whole surface of the frond. Brit. genera:

* Frond stalked, the stalk ending in an expanded leaf-like portion.

Alaria. Leaf membranous, with a cartilaginous midrib.

Laminaria. Leaf simple or cleft, without a midrib.

** Frond simple, leafless.

Chorda. Frond cylindrical, hollow, with transverse partitions.

LAMINOSIOP'TES, Mégn.—A genus of Acarina, allied to *Sarcoptes*.

L. gallinarum occurs in the subcutaneous tissue of the *Gallinæ* (Mégnin, *Paras.* 151, fig.).

LAOMEDE'A, Lamx.—A genus of Hydroid Zoophytes, family Campanulariidæ.

Char. Polypidom rooted, erect, jointed; the joints ringed and incrassate; cells alternate, campanulate, on short peduncles; vesicles axillary; embryos medusiform.

Six British species: *dichotoma* (ovicell, Pl. 33. fig. 4 *c*), *geniculata*, *gelatinosa*, *obliqua*, *Flemingii*, and *lacerata*. Found upon marine Algæ, stones, &c., between tide-marks.

Bibl. Johnston, *Br. Zooph.* 101; Gosse, *Mar. Zool.* ii. 24; Hincks, *Br. Zooph.*

LAOPHON'TE, Philippi.—A genus of Copepodous Entomostraca. Eight species, in dredgings. (Brady, *Copep.*, *Ray Soc.* ii. 70.)

LAR, Gosse.—A genus of Hydroid Zoophytes.

Char. Bodies fusiform, sessile, with two tentacula springing from the base of a bilobate proboscis, developed on a creeping and anastomosing stolon.

Lar sabellarum. The polypites bear a close resemblance to the human figure.

Bibl. Gosse, *Linn. Tr.* xxii. 113, tab. xx.; Hincks, *Br. Zooph.* 36.

LAREL'LA, Ehr.—A genus of Rotifera, fam. Brachionea.

Char. Body with equal setæ and three long fine hairs on each side of mouth; two frontal eyes; length 1-190 to 1-280″.

Bibl. Pritchard, *Infus.* 712.

LARVÆ. — In animals which pass through certain marked stages of development, or undergo metamorphosis, as it is called, the condition in the first of these stages is called the larval state, and the animal itself is called a larva.

The aquatic larvæ of several insects are well-known microscopic favourites on account of their transparence, which allows the action of the dorsal vessels, with the circulation of the nutritive liquid, to be seen, and their curious respiratory organs. A few of the more common aquatic larvæ and their parts are represented in Pl. 35. figs. 1, 14–17, 19–22, 29; these are noticed more in detail under their respective heads.

The aquatic larvæ of some Amphibia are admirable objects for exhibiting the circulation of the blood, the development of tissues, &c., as those of the frog (tadpoles) and of the *Triton*.

LASIOB'OTRYS, Ktz.—A genus of Perisporacei (Ascomycetous Fungi).

L. Loniceræ grows on the living leaves and stems of various kinds of Honeysuckle, forming little heaps seated on a tuft of radiating filaments. The so-called peridioles appear to be sclerotioid bodies, the superficial cells of which are converted into true perithecia, becoming free on the surface: these contain numerous asci when mature; but the spores have not been observed.

Bibl. Berk. *Br. Fl.* ii. pt. 2. 324; *Ann. N. H.* 2 ser. ix. 386, pl. 12. fig. 44; Fries, *Sum. Veg.* 406; Greville, *Sc. Crypt. Fl.* pl. 191.

LASTRÆA, Presl.—A genus of Aspidieæ (Polypodiaceous Ferns), now consolidated with Nephrodium.

LATEX.—The name applied to the peculiar juices, becoming milky when exposed to air, contained in the 'milk-vessels,' or *laticiferous canals* of plants, especially abundant in Euphorbiaceæ, Papaveraceæ, Cichoraceæ, &c. It appears to consist of a watery fluid, with albumen in solution, in which float globules of caoutchouc, or analogous gum-resinous matter, of variable size, occasionally mixed with starch-granules of peculiar forms, as in *Euphorbia* (Pl. 48. fig. 23). According to Sachs and Hanstein it is a fluid which contains matters of a directly nutritive character and others which are excrementitious in their nature. Trécul, on the other hand, appears to consider that the latex is the residue of the sap after elaboration by the cells. See Laticiferous tissue.

Bibl. Schultz, *Vaisseaux laticifères d. Plantes*, 1841; Mohl, *Bot. Zeit.* 1843; *Ann. N. H.* xiii. 441.

LATHONU'RA, Lilljeborg.—A genus of Cladocerous Entomostraca.

Char. Carapace obovate, not produced, ventral margin furnished with peculiar flattened spear-shaped plates attached to the edge. I Irish species.

Bibl. Norman & Brady, *Monogr.*, *Nat. Hist. Tr. Northumb.*

LATHRÆA.—A genus of Orobanchaceous Flowering Plants. *L. squamaria*, a remarkable plant, found here and there in beech-woods in England, has been the subject of much research as regards embryology, by Schacht and others. See Ovule.

LATICIFEROUS TISSUE, ducts, canals, or vessels.—These names are applied to the tubular and often ramified canals in which the milky juice or *latex* of many plants is contained (figs. 388, 389). The nature, or rather the origin, of these canals is still a matter of dispute. The ducts present themselves in various forms, especially in the rind and pith of the Apocynaceæ, Asclepiadaceæ, Moraceæ, Urticaceæ, Papaveraceæ, Cucurbitaceæ, Euphorbiaceæ, Aroi-

deæ, &c. Simple unbranched milk-vessels occur in the pith of the elder.

Schacht regards them all as liber-cells. They have also been considered intercellular passages, originally devoid of a proper coat, but subsequently acquiring one of variable thickness, derived apparently from the secretion which they contain; yet the presence of transverse partitions would invalidate

Fig. 388.

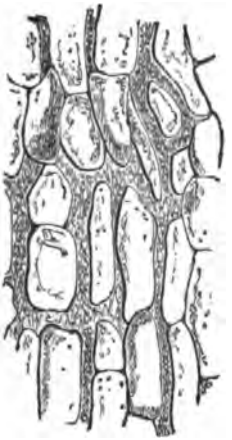


Fig. 389.

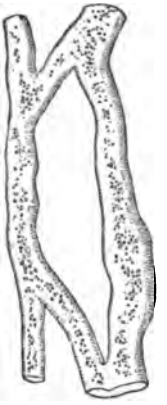


Fig. 388. Laticiferous canals from the root of Dandelion. Magn. 100 diams.
Fig. 389. Laticiferous tissue extracted from *Chelidonium majus*. Magn. 100 diams.

this view. Unger, however, imagines that, while some are formed in this way, they are mostly developed out of confluent rows of cells, like the dotted ducts; and Trécul is of opinion that they are ordinarily formed in this way. Dippel considers that they replace the clathrate cells of other plants.

Canals bounded by a defined coat of cellular tissue, forming intercellular canals or ducts of very definite character, occur in the Coniferæ, the Guttiferæ, Anacardiaceæ, &c. These will be spoken of under SECRETING ORGANS OF PLANTS.

Canals containing a milky juice occur in some of the Fungi, as in the fleshy substance of some Agarics, *Lactarius*, &c.

It was declared some years ago by Schultz that a regular circulation of the latex takes place through the ramified laticiferous ducts. This was chiefly supported on observations of movements of the latex which may be made on tolerably transparent parts of living plants containing these ducts. By bringing the uninjured sepal of *Convolvulus* or a leaf of *Chelidonium* under the microscope (placing it in oil is advantageous in the latter case), the branched latex-ducts may be made out, and a flowing movement of the particles may be seen occasionally. But this has been shown to depend upon a disturbance of the equilibrium by external causes, such as pressure and heat, and may be produced at will in any direction by making an incision, towards which the juice flows. Trécul thinks that the laticiferous canals communicate freely with the pitted ducts and other vascular elements, and take a share in a kind of circulation, wherein they play the part of venous reservoirs; but his views do not appear to us well founded.

BIBL. Schleiden, *Princip. of Bot.* 1849; Unger, *An. und Phys.* 1846, 54; Schacht, *Monat. Berlin Akad.* 1856; *Flora*, 1857, 89; Meyen, *Secretionsorgane*, 1837, 63; Trécul, *Ann. Sc. Nat.* 4 sér. vii. 290; Hanstein, *Milchsaftgefässe*, 1864; Dippel, *Milchs.* 1865; Vogel, *Jahr. wiss. Bot.* v. 31; Sachs, *Bot.* 88.

LAURENCIA, Lamx.—A genus of Laurenciaceæ (Florideous Algæ), containing several British species, mostly common, of yellowish-green, purple, or pink colour, the fronds pinnately branched, of solid parenchymatous structure. The *ceramidia* are

Fig. 390.

Laurencia dasyphylla.
Ramuli containing tetraspores.
Magnified 50 diameters.

borne on the smaller branches, as are also the *antheridia*; the *tetraspores* are imbedded in the ramuli (fig. 390). The *ceramidia* contain tufts of pear-shaped spores; the

tetraspores are tetrahedrally divided. The antheridia are thus described (in *L. tenuissima*) by Thuret: on the smaller branches, similar to those which bear the *ceramidia* on other individuals, occur greyish convoluted plates of cellular tissue, of irregular form, bordered by a line of roundish cells, containing generally a yellow liquid. Hyaline cells containing antherozoids are implanted vertically on these plates, clothing both surfaces. The antheridium has a sort of pedicel formed of an ovoid cell, which also bears a dichotomous hair, like those common over the branches of this plant. The antherozoids are elongated-ovoid, a little constricted at one extremity, length about 3-5000″. Derbès and Solier have observed them on *L. pinnatifida* and other species.

Bibl. Harvey, *Mar. Alg.* 97, pl. 12 C; *Phyc. Brit.* pl. 55; Grev. *Alg. Br.* 108, pl. 14; Derbès and Solier, *Ann. Sc. Nat.* 3 sér. xiv. 276, pl. 37; Thuret, *ib.* xvi. 65, pl. 7, *ib.* sér. 4. iii. 19.

LAURENCIA'CEÆ.—A family of Florideæ. Rose-red or purple sea-weeds with a cylindrical or compressed, rarely flat, linear, narrow, areolated, inarticulate, or constricted and chambered, branching frond composed of polygonal cells. *Fructification*: 1, *conceptacles* (*ceramidia*) external, ovate, furnished with a terminal pore, and containing a tuft of pear-shaped spores; 2, *tetraspores* immersed in the branches and ramuli, scattered without order through the surface cells; 3, *antheridia*.

British genera:

Bonnemaisonia. Frond solid, filiform, rose-red, much branched; branches margined with subulate distichous cilia.

Laurencia. Frond solid, cylindrical or flattened, purplish or yellowish, pinnatifid, ramuli blunt.

Chrysimenia. Frond hollow, filled with mucus, neither constricted nor chambered.

Chylocladia. Branches hollow, with mucus, constricted at intervals.

LEA'IA, Jones.—A fossil Entomostracan Bivalve, of unknown alliance, probably a Phyllopod. Valves oblong; marked with two obliquely transverse, divergent ridges, concentric lines of growth, and intermediate reticulation. Known in the Coal-measures of Britain and America.

Bibl. Jones, *Foss. Estheriæ*, 1862, 115; *Geol. Mag.* vii. 219.

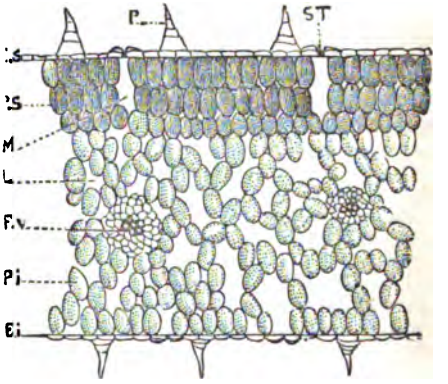
LEANGIUM, Lk. See Diderma.

LEATHE'SIA, Gray.—A genus of Myrionemaceæ (Fucoid Algæ), consisting of globose or lobulated fleshy or horny structures, growing upon rocks, either solid, or, by the solution of the internal filamentous substance, ultimately hollow. The fronds are composed of masses of dichotomous filaments radiating from a point; in the olive-coloured tufted species cohering laterally, and forming the soft, fine coat of the lobes. The *sporanges* are simple oval sacs attached to the ends of branches of the radiating filaments, between which they nestle; or multilocular, consisting of short septate filaments occurring in similar situations, which are said by Thuret to be more common; and the two kinds have not been met with together.

Bibl. Harvey, *Mar. Alg.* 48, pl. 10 C; *Engl. Bot.* pl. 1596; Thuret, *Ann. Sc. Nat.* 3 sér. xiv. 237, pl. 26. figs. 5–12.

LEAVES.—The microscopic structure of leaves presents a wonderful variety of conditions, from the most simple up to very complex. Instances of the former are seen in the Mosses, Jungermannieæ, and other Flowerless plants, where merely a simple cellular plate exists. In the simpler leaves of

Fig. 391.



Vertical section of a leaf of a Melon.

E. S, superior epidermis; *P. S*, subjacent close parenchyma; *M*, infra-stomatal air-space; *L*, intercellular space; *F. v*, fibro-vascular bundle (rib or vein); *P. i*, inferior lax parenchyma; *E. i*, inferior epidermis; *P*, hairs; *ST*, stoma.

Magnified 100 diameters.

Ferns, such as Hymenophyllum, we have a cellular plate traversed by vascular ribs. In Sphagnum (among the Mosses) the simple leaves have cells containing a spiral

fibre. In the more complete forms we distinguish an epidermis, above and below, often differing in character on the two faces (see EPIDERMIS and STOMATA), together with the *diachyma* or intervening cellular mass, which varies in its characters in different plants, and is traversed by the fibro-vascular ribs or veins. The epidermis exhibits GLANDS, HAIRS, &c., in different conditions and forms, which cannot be enumerated again here, many of the most interesting forms being mentioned under the above heads. For observing the structure of leaves, when consisting of more than a simple cellular plate, horizontal and vertical sections are required. The latter are easily made with a sharp razor in thick and firm leaves; but with delicate kinds it is necessary to split a soft cork, to place the leaf carefully between the pieces, and then to slice both together, placing the fragments in water and picking out the pieces of the leaf with a needle. Many small simple leaves make good objects by drying, soaking in turpentine, and mounting in balsam; the same may be done with petals, sepals, &c. The leaves of many water-plants, such as of *Vallisneria, Anacharis, Ceratophyllum, Hottonia*, &c., are very favourable for the observation of the rotation of the cell-sap (see ROTATION). They are of very simple cellular structure, having no epidermis, stomata, or fibro-vascular ribs.

Leaves also afford a large field for interesting study to the microscopist, in the examination of the colouring-matters and secretions in the cells, especially during the autumnal changes, of the development, &c., and moreover in the investigation of the parasitic Fungi which so frequently attack them both in the living and the decaying state.

LECAN'ORA, Ach.—A genus of Lecanorei (Lichenaceous Lichens), the species growing chiefly on rocks, stones, and earth. Thallus crustaceous, granular, rarely radiate; apothecia lecanorine; paraphyses distinct; thecæ either eight-spored or polysporous; spores simple.

BIBL. Hook. *Br. Flor.* ii. pt. 1; *Engl. Bot.* pl. 940; Leighton, *Lich.* 1879.

LECID'EA, Ach.—A genus of Lecideinei (Lichenaceous Lichens), containing numerous British species. The apothecia have a border of the same colour as the disk. Growing chiefly on rocks, sometimes on bark. *L. geographica*, growing on subalpine rocks, is a remarkable species.

BIBL. Hook. *Br. Fl.* ii. pt. 1. 177; *Engl. Bot.* pl. 245, &c.; Leighton, *Lich.* 240.

LECIDEI'NEI.—A tribe of Lichenacei, containing the genera *Lecidea, Odontotrema*, and *Schizoxylon*.

BIBL. Leighton, *Lich. Fl.* 240.

LECYTH'EA, Lév. See URED'INEI.

LEECH.—Two species of the genus *Hirudo*, which belongs to the class Annulata, are used for medicinal purposes, viz. *H. medicinalis*, in which the ventral surface is greenish, with black spots; and *H. officinalis*, in which these spots are absent.

The structure of the mouth of the species of *Hirudo* is curious. The mouth is triangular (Pl. 22. fig. 25), and placed in the middle of the anterior sucker. Each of its three sides is furnished with a semicircular jaw, of cartilaginous consistence (fig. 26, side view; fig. 27, view from above), upon the convex margin of which are placed a large number of partly calcareous teeth (fig. 26 *b*) arranged in a row. The teeth (fig. 28, *a* side view, *b* view from above) are flattened, somewhat triangular, and excavated at the base, so as to exhibit two short prongs (*d*). They are placed transversely upon the jaws, which are moved by powerful muscles, and thus produce the well-known wounds. And this cross direction of the teeth is probably the cause of the troublesome bleeding accompanying the bite of a leech, in consequence of the amount of laceration necessarily connected with it.

The species of *Hirudo* have ten minute eyes, arranged in the form of a horseshoe at the upper part of the anterior sucker.

The ova of leeches are deposited in a kind of cocoon, composed of triangular fibres, branched and interwoven so as to somewhat resemble a sponge, as which one of them was formerly described.

BIBL. Brightwell, *Ann. N. H.* 1842, ix. 11; Brandt and Ratzeburg, *Mediz. Zool.* ii.; Johnson, *Medicinal Leech*; Moquin-Tandon, *Monog. Hirudinées*; Savigny, *Descript. de l'Egypte*, xxi.; Audouin and Milne-Edwards, *Ann. Sc. Nat.* 1823, 27–30; R. Jones, *Outl. of An. Kingdom*; Gervais and Van Beneden, *Zool. Med.*; Schultze, *Zeits. wiss. Zool.* xii. 1862; Leuckart, *Mensch. Parasit.*; Gratiolet, *Ann. Sci. Nat.* iv. 17; Lankester, *Qu. M. Jn.* 1880, xx. 307.

LEIBLEI'NIA, Endl.—A genus of marine plants, placed among the Ectocarpaceæ by Endlicher, and among Oscillatoriaceæ (Confervoid Algæ) by Kützing, who includes

under it many of the species of *Calothrix* of other authors. Endlicher cites only *C. confervicola*, Ag., and another not British.

It is a minute, glaucous, tufted plant, formed of short, rigid, erect, subulate filaments, and is common, epiphytic on marine filamentous Algæ.

Bibl. Endl. *Gen. Plant.* Supp. iii. No. 69; Kütz. *Sp. Alg.* 276; Harvey, *Phyc. Br.* 223, pl. 26 C.

LEIOSO'MA, Koch.—A genus of Oribatea; has the cephalothorax with plates, the tarsi with three heterodactyl claws; two species. (Murray, *Ec. Entom.* 216, fig.)

LEJEUN'IA, Libert.—A genus of Jungermannieæ (Hepaticæ), containing several rare British species, found in subalpine districts, viz. *L. serpyllifolia, hamatifolia, minutissima*, and *calyptrifolia*. The last is one of the smallest of the British Jungermannieæ, and is remarkable for the peculiar form of its leaves, which resemble the calyptra of a moss (figs. 392, 393).

Fig. 392.

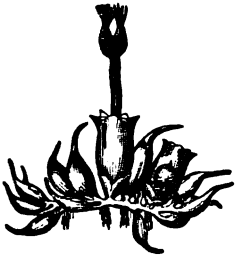


Fig. 393.

Lejeunia calyptrifolia.

Fig. 392. Stem with calyptriform leaves, an immature plant (on the right), and a burst sporange. Magn. 5 diams.

Fig. 393. A leaf of ditto. Magn. 25 diams.

Bibl. Hook. *Br. Jung.* pls. 42, 43, 51, 52; *Br. Fl.* ii. pt. 1, 127.

LEMANI'EÆ.— A family of Confervoideæ. Olive-coloured freshwater Algæ, filamentous, inarticulate, of cartilagineo-coriaceous substance, and compound cellular texture. The *fronds* branched, hollow, bearing within at irregular distances whorls of wart-like bodies consisting of tufted, simple or branched, necklace-shaped filaments (fig. 394), arising from the inner wall of the tubular frond, and finally breaking up into elliptical spores. British genus:

Lemania. Character the same as of the family. Two species have been found in Britain, *L. torulosa*, Ag., and *L. fluviatilis*. They always grow in clear running streams. Thwaites has made some interesting observations on the development of these plants.

Fig. 394.

Lemania torulosa.

Section of frond, showing the tufts of fertile filaments. Magn. 50 diams.

See Compsogon.

Bibl. Hassall, *Alg.* 68, pl. 7; Kütz. *Phyc. gen.* 271; Thwaites, *Ann. N. H.* 2 ser. i. 460; Wartmann, *Anat. d. Lemania*, 1854; Rabenhorst, *Alg.* iii. 410; Sirodot, *Lémanéac.* 1875 (23 pls.).

LEMBA'DIUM, Perty. — A genus of Holotrichous Infusoria.

Char. Body oval, flat, with a broad deep buccal fossa, having an undulate membrane on one side.

L. bullinum; marsh water.

Bibl. Claparède et Lachm. *Inf.* 251; Kent, *Inf.* 536.

LEM'BUS, Cohn.—A genus of Holotrichous Infusoria. Free, elongate, mouth ventral; a triangular ventral undulating membrane. Four species; marine. (Kent, *Inf.* 547.)

LEM'NA, L.—Duckweed. A genus of aquatic Monocotyledonous plants, remarkable for their simplicity of structure, the vegetative system being replaced by a minute leaf-like floating stem, with dependent rootlets, furnished with a well-developed sheath (*pileorhiza*) at the end. The lobes of the stem bear two monœcious imperfect flowers, and also propagate by bulbils formed in the slits in the side of the lobes; the young bulbils formed in autumn sink when the parent dies, and rise again in spring. Spiral vessels occur abundantly in *L. polyrhiza*; they are sparingly present in the rest.

Bibl. Hook. and Arnott, *Brit. Flor.*; Schleiden, *Bot.* 229; Weddell (*Wolffia*), *Ann. Sc. Nat.* 3 sér. 12, 155.

LEMON, Essential oil of.—This is sometimes used in the microscopic examination of pollen and other structures, which are placed in it to render them more trans-

parent, being less disagreeable and less volatile than oil of turpentine. Glycerine may often be substituted.

LENTICELS.—Structures found upon the surface of young stems, especially of most of the Dicotyledonous shrubs and trees. They first appear on the yearling shoot as little specks, of a different colour from the rest of the epidermis. Towards the winter, or in early spring, the epidermis splits transversely over the lenticels, which become then slightly projecting papillæ, frequently divided into lips, as it were, by a median furrow. The surface of the papilla is now brown; and it is of corky character for some little distance inwards. As the branch grows, the lenticels become drawn out laterally, so as to appear like cross striæ. They are subsequently lost sight of by the bark splitting through them, as in the apple or beech, or by the bark peeling off (plane).

Microscopic examination of sections shows that they are mere hypertrophal productions from the epiphlœum, or *suberous layer* of the BARK, and have no connexion with the liber or cambium. DeCandolle imagined they were root-buds, where adventitious roots might arise under favourable circumstances; but this was an error. Du Petit Thouars thought they were breathing-pores, replacing the stomata of the epidermis; but they are not pores; and many trees, such as the Conifers, Roses, *Euonymus europæus*, &c., have none.

BIBL. DeCand. *Ann. Sc. Nat.* 1826, vii. 5; Mohl, *Vermischt. Schrift.* 229, 233; Meyer, *Linnæa*, vii. 447; Unger, *Flora*, 1836, ii. 577; St. Pierre, *Compt. Rend.* 1855; *Ann. N. H.* 2 ser. xvi. 273.

LEPADEL'LA, Bory.—A genus of Rotatoria, of the family Euchlanidota.

Char. Eyes absent; foot forked.

Three species.

L. emarginata (Pl. 43. fig. 43). Carapace depressed, oval, anterior portion broad, emarginate at each end. Freshwater; length of carapace 1-570".

Teeth of *L. ovalis*, Pl. 43. fig. 44.

BIBL. Ehr. *Infus.* p. 457.

LEPEOPHTHI'RUS, Nordm.—A genus of Crustacea, of the order Siphonostoma, and family Caligidæ.

Char. Fourth pair of legs slender, not branched, formed for walking; thorax with only two distinct joints; frontal plates destitute of sucking-disks on the under surface. Six British species, found upon various marine fishes, as the salmon, mackerel, sole, brill, turbot, &c.

L. pectoralis (Pl. 19. fig. 23).

BIBL. Baird, *Brit. Entomost.* p. 273.

LEPERDITIA, Rouault.—An extinct bivalve Entomostracan, probably Ostracodous; bean-shaped; smooth; straight on the dorsal, convex on the ventral margin; smaller in front than behind; right valve overlapping the left along the ventral edge; each valve bearing a pitted and radiate muscle-spot and an ocular tubercle. The dorsal region of the left valve is swollen in some species. Fossil only.

30 Silurian species, 6 Devonian, and 14 Carboniferous, with many varieties.

BIBL. Jones, *Ann. N. H.* 2 ser. xvii. 81; 5 ser. ix. 168; *M. Mic. Jn.* iv. 184.

LEPIDOCYR'TUS, Latr.—A genus of Thysanura.

L. curvicollis is one of the insects which yield the so-called *Podura*-scales. The first segment of the thorax is as long as the two next, and projects so as to cover the neck and part of the head. It is found under stones or old wood. See PODURA.

LEPIDOP'TERA.—An order of Insects, consisting of butterflies and moths.

Lepidopterous insects present several points of interest to the microscopic observer; among these may be mentioned especially the proboscis or ANTLIA, the hook connecting the wings (INSECTS, p. 432), the wings themselves, and the beautiful scales covering them (SCALES OF INSECTS, TEST-OBJECTS). Their larvæ or caterpillars are favourable subjects for the examination of the internal structure—the tracheæ with their spiracles, the fatty body, the alimentary canal, the spinning organs, the curious legs, &c.

LEPISMA, Linn.—A genus of Thysanurous Insects, family Lepismenæ.

Char. Body elongated, flattened; antennæ setaceous, with numerous very short joints; palpi four, long; abdomen terminated by three long filaments jointed near their ends.

L. saccharina (Pl. 35. fig. 18). Body silvery-grey, not spotted, covered with scales; caudal filaments speckled with reddish brown; antennæ about two-thirds the length of the body.

This active little insect, which runs but does not jump, is found (in the country) upon the shelves of cupboards where sweets and other eatables are kept, in window-

cracks, &c. Its habits are nocturnal. Its beautiful silvery scales are used as TEST-OBJECTS (Pl. 1. fig. 6).

There are many other species, the scales of which probably exhibit the same structure.

BIBL. Gervais, *Walckenaer's Aptères*, iii. p. 450; Lubbock, *Linn. Trans.*

LEPRA'LIA, Johnst.—A genus of Cheilostomatous Polyzoa, family Membraniporidæ (Escharidæ, Hincks).

Char. Polypidom adnate, crustaceous, formed of a layer of juxtaposed urceolate cells, closed in front, and spreading circularly.

The very numerous species form white, yellow, or reddish crusts upon rocks, shells, and sea-weeds. Avicularia and vibracula present in some, but absent in others. Mouth of cells sometimes with spines.

L. variolosa (Pl. 41. fig. 17). Cells oblong, depressed, roughish, interstices punctured; orifice semioval or roundish, margin plain. On stones and shells, common; varieties occur with the lower lip notched, or with a tooth.

L. unicornis. Cells ovate, scaly, with a short obtuse process or knob above the orifice, which is roundish, with a distinct notch in the upper margin; common.

BIBL. Johnston, *Br. Zooph.* 300; Busk, *Mar. Polyz.*; Hincks, *Polyz.* 297.

LEPTOCLINUM, M.-Edw.—A genus of Tunicate Mollusca, of the family Botryllidæ.

Distinguished by the thin, sessile, incrusting mass of variable form, the numerous systems, the six-rayed branchial orifice, and the anal orifices opening into a common more or less branched cloaca.

Six British species: *maculosum, asperum, aureum, gelatinosum, Listerianum*, and *punctatum*, found upon the roots of *Laminaria* and other marine algæ; the two former common.

BIBL. Forbes and Hanley, *Br. Mollusca*, i. 16; Gosse, *Mar. Zool.* ii. 32; M.-Edwards, *Mém. sur les Ascid. comp.*

LEPTOCYSTINE'MA, Archer, = GONATOZYGON, De Bary, 1856.

LEPTODIS'CUS, Hertwig.—A genus of marine Flagellate Infusoria.

L. medusoides, diam. $\frac{1}{4}$''; Messina. (Kent, *Infus.* 400.)

LEPTOGID'IUM, Nyl.—A genus of Collemacei (Byssaceous Lichens). *L. dendriscum*, on mossy trees on high mountains. (Leighton, *Lich. Fl.* 13.)

LEPTO'GIUM.—A genus of Collemaceous Lichens. Thallus with a distinct cortical layer, granula; gonima moniliform; apothecia lecanorine; spores eight, multilocular, rarely simple. Species numerous. On mossy trunks, walls.

BIBL. Leighton, *Lich. Flor.* 25.

LEPTO'MONAS, Kt.—A genus of Flagellate Infusoria. Free, narrowly fusiform, flagellum single.

L. Bütschlii, in the intestine of *Trilobus gracilis.* (Kent, *Inf.* 243.)

LEPTOS'CYPHUS, Allman.—A genus of Hydroid Zoophytes.

Char. Capsules ovato-conic; polypes cylindrical, proboscis conical; reproduction by free medusiform bodies.

L. tenuis, on *Laminaria*; Stromness.

BIBL. Allman, *Ann. N. H.* 1864; Hincks, *Br. Hyd. Zooph.* p. 196.

LEPTOSTRO'MA, Fr.—A genus of Sphæronemei (Stylosporous Fungi), probably consisting only of the younger stylosporous states of species of HYSTERIUM or PHACIDIUM. Several species are recorded as British, some common, occurring on the stems and leaves of sedges, rushes, *Pteris*, &c., forming small round flat spots, from which the upper part of the *perithecium* splits off, leaving a little margined scar, in which are seated the stylospores.

BIBL. Berk. *Br. Fl.* ii. pt. 2. 297; *Ann. N. H.* i. 257, vi. 365; Tulasne, *Ann. N. H.* 2 ser. viii. 114.

LEPTOTHRICHE'Æ.—A subfamily of the Oscillatoriaceæ. Filaments very fine, adnate, sheathed, indistinctly articulate; movement slow; solitary or fasciculate; for the most part in broad and diffused layers.

BIBL. Rabenhorst, *Fl. Alg.* ii. 8 & 73.

LEP'TOTHRIX, Kütz.—A supposed genus of Oscillatoriaceæ. Found on damp stones, among wet plants, and in foul water; very probably consisting of the mycelial filaments of mildew Fungi.

The filaments are very slender, simple, continuous or obscurely jointed.

L. ochracea, K. (*Oscillatoria ochracea*, Grev.) is an obscure production, forming yellowish-brown flocculent masses, common in boggy pools.

L. buccalis and *L. insectorum*, Ch. Robin, probably belong to some Fungus.

BIBL. Kütz. *Sp. Alg.* 262; *Tab. Phyc.* i. pl. 61. fig. 1; Robin, *Végét. Parasit.* 2nd ed. 345, 355; Mettenheimer, *Mus. Senckenb.* 1857, 139; Moggridge, *Jn. M. S.* 1868.

LEPTOTHY'RIUM, Kütz.—A genus of Sphæronemei (Stylosporous Fungi).

L. juglandis, Lib., *L. fragariæ*, and *L. ribis* have been found in Britain; they are probably stylosporous forms of Ascomycetes.

BIBL. Fries, *Sum. Veg.* 371, 423; Berkeley, *Ann. N. H.* 2 ser. v. 371; Tulasne, *Ann. Sc. Nat.* 4 sér. v. 115.

LEPTOTRICHA'CEÆ.—A family of operculate Acrocarpous Mosses, branching by innovations, or with the fertile summits several times divided. Leaves lanceolate or awl-shaped, often canaliculate-concave, with a nerve, mostly flattened or terete; cells prosenchymatous, often mingled with parenchymatous, lax or firmish, empty, not unfrequently thickened at the apex, then square. Capsule ovate or cylindrical, sometimes naked, sometimes erect, often strumulose at the base; operculum conical or subulate. Differing from Dicranaceæ in the absence of alar cells to the leaves. Brit. gen.:

Angstræmia, *Brachyodus*, *Campylostelium*, *Leptotrichum*, *Seligeria*.

LEPTOTRICHUM, Hampe.—A genus of Acrocarpous operculate Mosses, including certain *Didymodonta* and *Trichostoma* of other authors.

LEPTOTRICHUM, Corda.—A genus of Sepedonei (Hyphomycetous Fungi); not British.

LEPTUS, Lam. See TROMBIDIUM.

L. autumnalis (*Trombidium autumnale*), the harvest-bug.

LERNÆA.—A genus of Pœcilopoda (Crustacea).

L. branchialis, on the gills of the cod. (Baird, *Br. Entom.* 344.)

LERNEONE'MA, Edwards.—A genus of Siphonostoma (Crustacea).

Char. Body long, slender, narrowed anteriorly in the form of a neck, terminated by a swollen head, with two or three simple, curved, horn-like appendages; abdomen of inconsiderable length, simple; oviferous tubes long and slender.

Two British species: *L. spratta* (Pl. 19. fig. 24), length 2 inches; and *L. encrasicholi*. Both found upon the sprat.

BIBL. Baird, *Brit. Entomostraca*, 339.

LESKEA, Hedw.—A genus of Mosses. See HYPNUM.

LEUCINE, or caseous oxide, is a normal constituent of the lungs, spleen, pancreas, the salivary glands, &c., and is produced during the putrefaction of albuminous and gelatinous matters. Usually accompanied by tyrosine, it crystallizes in minute spheres, which frequently unite and form radiating clusters, which often present a yellow tinge and a concentric lamination. It is soluble in water, less so in alcohol. The alkaline pancreatic juice transforms albumen into leucine and tyrosine. It also occurs in the Crustacea, Arachnida, and Insecta.

BIBL. Frey, *Hist.* 49; Rindfleisch, *Path. Hist.* 14; Voit, *Köll. & Sieb. Zeitsch.* ii. 1868.

LEUCO'BRYUM, Hampe.—A genus of Bryaceæ, Acrocarpous Mosses, but exhibiting also lateral fruit-stalls. Capsule, lid, and peristome as in *Dicranum*; but the leaves whitish, spongy, and composed of two layers of cellular tissue, the nerve indistinct.

L. glaucum. On moist heaths, woods, &c.

BIBL. Wilson, *Bryol. Br.* 82.

LEU'COCYTES.—These are the colourless corpuscles of the blood, lymph, &c.

LEU'CODON, Schwægr.—A genus of Pleurocarpous Mosses.

Char. Capsules oval, erect, pedicel short, calyptra large; outer teeth 16, bifid or perforated, not hygroscopic; shoots simple; leaves plicato-striate, nerveless.

L. sciuroides, trunks of trees and walls, frequent; *L. Lagurus*, rare. (Wilson, *Bryol. Br.* 313.)

LEU'COPHRYS, Ehr.—A genus of the family Bursarina (Ciliated Infusoria.)

Char. No sheath; body truncated in front obliquely; buccal cirri surrounding the truncation; anus at the posterior extremity; no watch-glass organ; no rows of cilia in the interior of the buccal fossa.

Ehrenberg describes eight species; they are found in salt and fresh water, both sweet and putrescent.

L. patula (Pl. 31. fig. 38, *a* dorsal, *b* ventral surface). Body ovato-campanulate, hyaline or white, turgid; mouth large, patulous. Freshwater and marine. Length 1-288 to 1-96″. The alimentary canal, with the sacculi, according to Ehrenberg's view, is represented in fig. 31 *a*.

L. spathula (*Spathidium hyalinum*, D.) (Pl. 31. figs. 75, 76). Body lanceolate, compressed, whitish, membranous, obliquely truncated and dilated in front; freshwater. Length 1-144″. Dujardin denies the existence of the anterior row of cilia. A very doubtful form.

Pl. 31. fig. 37 represents *L. striata*, D., which is one of the Opalina.

BIBL. Ehrenb. *Inf.* 311; Duj. *Inf.* 458; Stein, *Inf.* 184; Clap. et Lachm. *Infus.* 1868.

LIBELLULIDÆ.—A family of Insects, of the order Neuroptera. It contains several common but beautiful insects, some of which are popularly known as Dragon-flies and horse-stingers, although they are harmless. The great interest connected with them relates to the structure of the larvæ and pupæ, which live in water, and are furnished with branchiæ, either internal or external, situated at the end of the body. External branchiæ are seen in *Agrion* (Pl. 35. fig. 17). They consist of three membranous plates (Pl. 35. fig. 2 *g*), traversed by innumerable tracheæ. In *Æschna*, *Libellula*, and *Calepteryx* the branchiæ are internal and situated within the rectum (Pl. 35. fig. 20, rectum of *Æschna*). In this last genus the branchiæ are in the form of plates, which are numerous, semicircular, longitudinal, imbricated, and arranged alternately in six regular and symmetrical columns. The laminæ consist of a network of fine tracheæ, communicating with those of the body and situated beneath the mucous membrane.

The end of the abdomen is furnished with five movable valvular pieces (Pl. 35. fig. 29), three of which are larger than the others, and the uppermost of which is notched at the end. These pieces, by their contraction, expel the water from the rectum; it is renewed; and the expulsive force effects the locomotion as well as the respiration of the insect. The labium of *Æschna* also possesses a remarkable structure, forming an elongated, somewhat spatulate, mask-like appendage, which completely closes the mouth when unemployed (Pl. 50. fig. 16). In the other genera the structure is very similar. In *Libellula* six biserial rectal columns are also present; but there are no papillæ on them; and the caudal appendage is pointed and not notched (Pl. 35. fig. 22). In *Calepteryx* the rectal branchiæ are more simple, consisting of three plates attached only by the end, and resembling in structure the external plates of *Agrion*; the ocelli are distinct; and the external caudal aperture consists of three channelled and keeled pieces. The spiracles of these larvæ and pupæ are more or less concealed in the interspace between the proto- and mesothorax; they are transverse, bilabiate, and furnished with a musculo-membranous valve.

BIBL. Dufour, *Ann. Sc. Nat.* 1852, xvii. 65; Westwood, *Introd.*; Packard, *Amer. Natur.* v. 1871; Oustalet, *Ann. Sc. Nat.* xii.; Selys-Longchamps, *Mon. Libell. d'Europe*; Charpentier, *Libell. Europ.* 48 pls.; Lenderfeld, *Wings of*, 1881.

LI'BER (Phloëm).—The term liber-cells or -fibres is applied to the very long prosenchymatous cells, occurring isolated or in bundles at the outside of the cambium-layer of Dicotyledons, and often in the pith and the ribs of the leaves; to the cells of similar form and character occurring in the outer part of the fibro-vascular bundles of Monocotyledons, and in the branches of those containing no spiral structures; also to the fibrous cells of the same kind found in the husks of many fruits, as the cocoa-nut; they are constantly ringed with sieve-cells or -tubes. No exact line of demarcation can be drawn between liber-cells and wood-cells, since the shorter of the former pass into the latter. As a rule they are much thickened by secondary deposits (Pl. 47. fig. 27); but these deposits are tougher than those of the wood-cells; and while they have *pores*, these are never bordered with a rim. Liber-cells are not unfrequently found branched (Rhizophoraceæ, *Gnetum*); and some of the branched forms are supposed to originate by the confluence of originally distinct cells, after the manner of milk-vessels.

The layers of thickening on the walls of liber-cells frequently exhibit a spiral striation, especially after treatment with acids (Pl. 28. figs. 2, 3, 25). Mohl has pointed out the peculiar characters of certain structures associated with liber in the bark of Dicotyledons and in the vascular bundles of Monocotyledons. These are the *vasa propria*, and are described under VASCULAR BUNDLES.

The importance of liber as a material for textile fabrics has been spoken of under FIBROUS STRUCTURES, and examples cited; figures of various kinds of liber-fibre are given in Plate 28.

In Dicotyledonous stems the liber-fibres are usually placed in large bundles opposite the fibro-vascular bundles of the wood, as in *Urtica*, *Viscum*, *Clematis*, *Quercus*, &c.; sometimes in small irregular groups, as in *Vinca* and *Linum*; in other cases they stand in single rows, alternating with parenchyma or *vasa propria* (*Cupressineæ* and *Taxineæ*), while in many plants they are irregularly scattered, as in *Rhizophora*, *Cinchona*, *Nerium*, &c. Isolated liber-cells occur in the pith of young shoots, and may

be readily seen in the long woody radicles developed from the seeds of the Rhizophoreæ (Pl. 48. fig. 31); and in the bark and pericarp of *Gnetum*, isolated branched liber-fibres occur scattered throughout the whole mass.

In many Dicotyledons the thick-walled liber-cells are formed only in the first year, the subsequent formation in this region consisting of new layers of *vasa propria* and parenchymatous cells (*Betula alba* and *Fagus sylvatica*). In *Viburnum Lantana* the thick-walled liber is entirely wanting.

In the Monocotyledons they occur associated with short wood-cells in the fibro-vascular bundles; but they form alone the *fibrous bundles* often intermixed with and prolonged from the ends of these, occurring especially in the outer part of the stem of herbaceous Monocotyledons, such as Lilies and Grasses, and in the fleshy cortical layer of rhizomes, as in *Sparganium*, &c.

In both families they occur with the spiral vessels and wood-cells in the ribs or veins of leaves (as in *Phormium tenax*), bracts, spathes of Palms, &c.

Liber-cells are generally drawn out very gradually to a point at each end; sometimes they are very long; Schleiden states he has seen them 5″ or 6″. Sometimes they exhibit expansions at particular points, as in the Apocynaceæ. The branched forms in Rhizophoreæ, *Gnetum*, &c. are usually much shorter than the simple fibres, and their form is often very irregular (Pl. 48. fig. 31). The diameter varies a great deal in some plants; and we should scarcely venture to say that the microscopic appearance of a liber-fibre would suffice for the determination of the material of any (vegetable) textile fabric, beyond the distinction of *cotton* (or vegetable *hair*) from *linen* or other *liber*; but reagents affect them differently. The appearance presented by many kinds of fibre under the microscope, in the state in which they occur in commerce and after treatment with acids, is shown in Pl. 28. figs. 2–7, 25 & 26. The figures are taken from very characteristic examples; but many modifications occur in subordinate quantity. Flax (*Linum usitatissimum*) (fig. 2) has the walls much thickened, with distinct pores; it exhibits a very oblique close striation after boiling with nitric acid. Jute, the liber of *Corchorus capsularis*, has thinner walls, with constrictions at intervals and blunter ends (fig. 3); no spiral streaks come out here on boiling with nitric acid. The fibre from the Cocoa-nut husk occurs in bundles (fig. 4); when isolated or boiled with acid, the walls are found thin, with wide, open, spiral streaks (slits in the secondary layers); the ends are blunt (fig. 5 *a*, *b*). The fibre of hemp (*Cannabis sativa*) somewhat resembles flax, but is coarser and becomes swollen up and brittle, readily breaking across, when boiled with nitric acid (fig. 6); no spiral streaks. The liber-fibres from the bundles of *Musa textilis* (fig. 7) are fine and tough, and not much altered by boiling. Those of *Bœhmeria nivea* (fig. 25) are coarse, rough on the outside; they swell up and exhibit marked spiral slits when boiled with acid, and also distinct lamination of the thick wall (fig. 25 *c*). *Bœhmeria Puya* (fig. 26) closely resembles the former; but the spiral striation is not very evident, and the wall splits readily in the longitudinal direction (fig. 26 *c*). The spiral striation is well seen in fig. 30 of Pl. 48, which represents the end of a liber-fibre from *Vinca minor* after boiling with nitric acid.

The *liber-bundles* of bark are sometimes set free as loose stringy fibres by the decay of the outer parts of the bark, as in the vine, *Clematis*, &c. In some plants they take a wavy course, anastomosing laterally so as to form connected reticulated sheets over the cambium: in the Lime (*Tilia*) these sheets may be detached by maceration, and they form *bast*, the material used for matting, &c. In the Thymeleaceæ (lace-bark trees) the annual layers of liber can be detached from each other, and form sheets of fibrous tissue, sometimes firm and tough, sometimes almost as delicate as muslin.

Bibl. Mohl, *Bot. Zeit.* xiii. 873; Schacht, *Pflanzenzelle*, 208; *Ann. Sc. Nat.* 4 sér. viii. 164; Sachs, *Bot.* 121; Henfrey-Masters, *Bot.*

See also under Laticiferous Tissue.

LICEA, Schrad.—A genus of Myxomycetes, growing on damp rotten wood, in garden frames, &c., with the peridia elongate, grouped together, of only one layer, and containing few or no filaments among the spores. Four species are described as British, of which *L. fragiformis*, Nees, is not uncommon on wet very rotten wood, moss, &c.; the groups of peridia just before maturity somewhat resembling a strawberry, afterwards brownish.

Bibl. Berk. *Br. Fl.* ii. pt. 2. 321; *Ann. N. H.* 2 ser. v. 367; Greville, *Sc. Crypt. Fl.* pl. 328: Fries, *Syst. Mycol.* iii. 195; *Sum. Veg.* 458.

LICHENOP'ORA, Def.—A genus of

Cyclostomatous Polyzoa (*Tubulipora*, pt., Johnst.). Four species; on marine zoophytes, stones, and shells. (Hincks, *Polyzoa*, 471.)

LICHENS.—A class of Thallophytes or cellular plants standing between the Algæ

Fig. 395.

Sphærophoron coralloides.
Thallus with apothecia.
Nat. size.

and the Fungi, exhibiting in the various genera relations sometimes approaching very

Fig. 396.

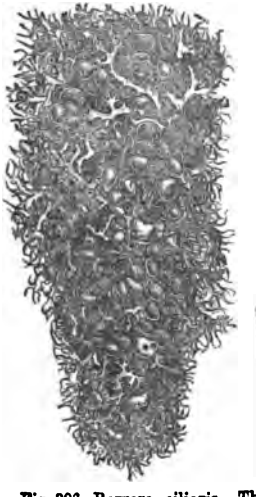


Fig. 397.

Fig. 398.

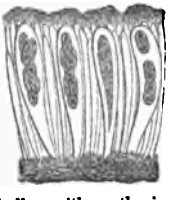


Fig. 396. Borrera ciliaris. Thallus with apothecia. Nat. size.

Fig. 397. Opegrapha atra. Thallus with lirellæ. Nat. size.

Fig. 398. Section of thalamium. Magn. 150 diams.

closely to the one, sometimes to the other of these two classes. The parasitic Lichens, such as ABROTHALLUS, being destitute of a free thallus and of green gonidia, are undistinguishable from Fungi by any definite character.

The Lichens are almost universally either dry incrusting bodies, growing upon bark of trees, stones, earth, &c., as a pulverulent, or rough and horny, or laminated and mostly wrinkled and curled crust (fig. 397); or as horny or leathery, foliaceous or shrubby, ragged or bristling patches (figs. 395 & 396), seldom rising much from the surface which they overgrow; of grey, greyish green, brown, yellowish, or even reddish colour, and with a dead, pulverulent, and opaque surface. Some, however, are parasitic on other Lichens, as *Abrothallus*, or upon living leaves, as *Strigula*. They derive their nourishment from the air; and are usually recognized by their dry crustaceous habit, and the presence of gonidia.

In the simplest kind of Lichens, the thallus consists of microscopic branched filaments (*hyphæ*), penetrating among the superficial layers of the cells of the bark or epidermis upon which the plants grow. These filaments usually present globular cells here and there arising from them, filled with green matter, which are capable of reproducing the plant when detached; they are called *gonidia*, and are regarded as analogous to the *buds* of the Fowering plants and the cellular *gemmæ* of the higher Cryptogams. The gonidia consist either of simple cells containing green granular matter (Pl. 37. fig. 6 *g*), or of clusters or strings of green granules, when they are called *granula gonima* (Pl. 35. fig. 13). Sometimes these granules form spherical concretions upon the thallus, and are called *cephalodia*. The gonidia have been stated to produce zoospores; while these again are declared to be granules in molecular motion. In the simple forms here alluded to, the gonidia are not sufficiently numerous to give a coloured tinge to the structure as seen by the naked eye; in some even the filaments make no show, while in others they form whitish patches (*Opegrapha*, *Verrucaria*). In the forms rather more developed we find a layer of globular epidermal cells, with whitish contents, closely coherent together, constituting a "cortical layer" covering the upper surface, to which the filamentous structure or *hypothallus* then forms the "medullary layer." The crustaceous kinds overgrowing stones have this filamentous

medullary layer very solid; and in some of them its lowest filaments are seen growing out all round the borders, in the direction in which the plant is extending, the upper filaments with the gonidia and the cortical layer by degrees overgrowing these lowest filaments, which in the meantime have extended further out. Some of the crustaceous Lichens grow out in more or less regular lobes at their borders, and thence lead to the pseudo-foliaceous forms, of which the common *Parmelia* (*Physcia*) *parietina*, the yellow Lichen so abundant on walls, and *Borrera ciliaris*, common on branches of trees (fig. 396), may serve as examples. The thin paper-like thallus of the former exhibits *four* distinct regions (Pl. 37. fig. 2): —1, on the upper face a layer of thick cells, firmly connected together, coloured yellow at the surface (*upper cortical* or *epidermal layer*); 2, a layer like the preceding, but white, forming the inferior surface of the thallus (*lower cortical* or *epidermal layer*); 3, beneath the upper cortical layer lie the *gonidia*; and 4, under these lie the *medullary* filaments forming the central substance, at the upper part of which lie the gonidia arising from these filaments. These are interlaced and imprison air between them. From the lower face arise laminæ or fibrous processes, like roots (*rhizinæ*), serving as cramps by which the plant attaches itself to the surface on which it grows. In *Peltigera canina* there is no inferior epidermal or cortical layer, the filamentous medullary structure forming the irregular veined surface, prolonged here and there into pseudo-radical processes. In *Endocarpon* and other fronds of solid texture, the medullary layer is formed of slender linear cells, closely packed, with few air-passages. The species of *Cladonia* exhibit a structure of the thallus intermediate between that of the foliaceous kind just referred to and the shrubby sort. In the foliaceous expansion resting on the ground, of *C. pyxidata*, for example, we detect the upper epidermis, next the gonidial layer, which again rests on the closely-felted filamentous medullary substance. In the branches of *C. rangiferina*, as in a great number of its congeners, there is no well-defined epidermis. The branches are tubes, vacant in the centre, formed of a cartilaginous structure, in which only two zones can be distinguished, the inner and more solid of which is composed of almost simple, parallel, solid filaments intimately glued together by mucous substance; the outer zone is formed of a felted mass of filaments, likewise solid, but branched and divaricated. The solidity of these filaments arises from the obliteration of the cell-cavity by secondary layers on its walls, giving the filaments a horny texture. In the outer loose layer are found scattered groups of gonidia. In *Stereocaulon denudatum* the branches are solid and formed exclusively of parallel filaments, as is the case also with those of *Ramalina scopulorum*. In *Evernia vulpina* there is a solid axis formed of parallel filaments enclosed in a layer of interlaced fibres, between which and the horny coat, which is either solid or very obscurely cellular, gonidia are here and there to be observed.

In many Lichens, when exposed to excess of moisture, the proper fructification is not developed, and the gonidial structure is produced so abundantly as to burst through the superficial cortical layer and become naked, giving a mealy appearance to the thallus. Lichens reproduced by gonidia commonly grow at first into a pulverulent stratum by the multiplication of the cells, giving rise to the forms which were at one time thought distinct genera, such as *Lepraria*.

The gonidia have been stated to produce motile zoospores; but these are now considered molecular granules.

The fronds of *Collema* are remarkable for their gelatinous texture, and approach the Nostochaceæ (Algæ) in the simplicity of their structure; thus, the thallus of *C. cheileum* consists of branched and colourless filaments or tubes imbedded in an abundance of mucilage; in *C. jacobeæfolium*, there exist in addition very numerous *granula gonima*, almost all arranged in long beaded lines (Pl. 37. fig. 13), some being larger than others, the whole mixed with the continuous filaments and imbedded in mucus. Both species have long, whitish, branched, filamentous pseudo-radical processes.

Putting aside the *gonidia* or gemmule-cells of the thallus, the reproductive organs of the lichens are of three kinds:—1, the *apothecia*, which, according to their forms, receive different names, and are all characterized by producing the sacs (*thecæ*) containing spores; 2, the *spermogonia*, which some regard as antheridia, and which produce extremely minute cylindrical bodies (*spermatia*) growing at the ends of short pedicels, from which they are ultimately detached, like the spores of many Fungi;

and, 3, *pycnidia*, in which are developed *stylospores* like those of Fungi.

The commonest form of the *apothecia* is that of sessile or stalked disks or cushions, flat, convex, or hollowed into a cup (fig. 396); in other cases they are linear; these open forms characterize the formerly-called Gymnocarpous Lichens. While in the Angiocarpous genera the apothecia or rather perithecia are closed globular receptacles or conceptacles, analogous to those of the *Sphæriæ* among the Fungi, and opening at the summit to discharge the spores (fig. 395). The *apothecium* may be composed of two parts—the *thalamium* or *hymenium*, and the *excipulum*. The excipulum, when present, sometimes forms a cup-like envelope derived from the thallus, and of the same colour (*thalline*), or it may differ in colour and texture, in which case it is termed *proper*. Or it may entirely or partly surround the thalamium and thecæ, and then forms the *perithecium*. The *thalamium* is represented by the body of the apothecium, open or closed; and the layer of its cells immediately lining the bottom of the cup, shield, or conceptacle is sometimes called the *hypothecium*, which bears the *thecæ* and the *paraphyses* (fig. 398); the latter are filiform or clavate cells (Pl. 37. figs. 6 & 12), probably abortive thecæ, among which they are intermingled; both these and the thecæ stand perpendicularly upon the hypothecium, being surrounded by a gelatinous substance—the *gelatina hymenea*. The *thecæ* (Pl. 37. figs. 6 & 12) are usually ovoid or elongated cells with thick walls, containing the spores; the thecæ are shorter than the paraphyses surrounding them; and the whole are usually glued firmly together by their contiguous lateral surfaces.

The *spores* consist of two layers, an epispore and an endospore; the former are tinged blue with tincture of iodine, and present many points of difference in different genera and species. In *Verrucaria muralis* they are ellipsoid, colourless, perfectly smooth and semitransparent, containing granular matter; while in *V. epidermidis* and *atomaria* they are bilocular bodies, representing a pair of obovoid cells adherent by their thick ends. In their earlier stages of development they appear solid; subsequently four nuclei or oily globules are seen in them, each occupying a spherical cavity. The membrane of the spore then becomes thinner, and finally its two cavities coalesce into one. When ripe, these spores are about 1-1500″ in length and about 1-4000″ broad. There are eight in each theca, and they are separately enveloped in a mucilaginous coat. The spores are largest in the genus *Pertusaria*. Those of *P. communis* are visible to the naked eye; and observed in water soon after emission from the thecæ, they are not less than 7-1000″ to 8-1000″ long by 5-1000″ broad. Their simple cavity is filled with granular semitransparent matter, usually with oil-globules of various sizes. The epispore is very broad, transparent, and formed of several lamellæ; these also are coated with mucus. The genus *Parmelia* (*Physcia*) offers both simple and bilocular spores. Of the former, *P. parietina* gives an example, though in some cases a transverse partition is formed, and this is the normal state in *P. stellaris* (Pl. 37. figs. 6 & 7). In *Peltigera* (Pl. 37. fig. 11) the spores are elongated. In *Collema* and other genera the spores are divided into four chambers by three transverse septa.

In several species of *Lecanora*, *Lecidea*, *Urceolaria*, &c., a more complex form of spore exists, longitudinal together with transverse septa dividing the cavity into several series of chambers. Those of *Urceolaria* (Pl. 37. fig. 17) have eight or ten compartments; those of *Lecidea urceolata*, *Thelotrema lepadina*, *Umbilicaria pustulata* (Pl. 37. fig. 18), and other Lichens, called muriform spores, have a much larger number of little cavities, each containing a distinct *nucleus*.

The emission of the ripe spores takes place in the same way as in the *Peziæ*, *Helvellæ*, *Sphæriæ*, and many other Fungi of the same kind. If a portion of the thallus, moistened, is placed in a common phial, with the apothecia turned toward one side, in about eight or ten hours the surface of the glass opposite each apothecium will be found covered with patches of spores, easily perceptible by their colour, these having been projected from the apothecia with force. If placed on a moist surface, and a slip of glass laid over them, the latter will become covered with them in the same way; and Tulasne states that they are projected to a distance of more than half an inch from the theciferous layer, the spores being emitted continuously for a long time. The experiment may be tried either in winter or summer, and has been made with success on several common species of *Parmelia*, *Lecanora*, *Peltigera*, *Collema*, *Borrera ciliaris*, *Verrucaria muralis*,

Endocarpon hepaticum, Pertusaria, Urceolaria, Opegrapha, &c.

Eight is generally set down as the normal number of spores in each theca; but this is not universal here any more than in the Ascomycetous Fungi; some species of *Endocarpon, Parmelia,* &c. have polysporous thecæ containing a considerable number, while there are often less than eight.

Spermogonia. The Lichens exhibit another form of reproductive organs, which are liable to be confounded with *Sphæronemei* and other Fungi growing on the Lichens, or with parasitical Lichens in similar positions. They form black or brown points, usually near the margins of the thallus (Pl. 37. fig. 1), and have been found in *Borrera, Parmelia, Sticta, Cladonia, Collema, Opegrapha, Sphærophoron, Lichina, Endocarpon,* &c., and seem to be universal.

The spermogonia are hollow pustules (Pl. 37. figs. 3 & 13) filled with filaments (*spermatophores,* Pl. 37. fig. 3) producing extremely minute bacilliform corpuscles (usually *spermatia*). They are immersed in the substance of the thallus (Pl. 37. figs. 2 & 13), and are perceptible externally only by a little projection, if at all; in rare cases they are free and borne above the thallus (some *Cladoniæ, Cetrariæ, Gyalectæ,* &c.). Their ordinary form is globular, ellipsoidal, or irregularly oblong, sometimes sinuous. They have either a simple undivided cavity (Pl. 37. figs. 13 & 16), or are multilocular, divided in different ways into a variable number of separate chambers or narrow cavities, communicating with a common orifice, the *ostiole* or *pore* of the apparatus. This structure bears a close relation to that usual in the Coniomycetous Fungi *Cytispora, Septoria,* &c., and bears testimony to the close connexion between the Lichens and Fungi. The *spermatia* are regarded as analogous to the spermatozoids in the antheridia of the higher Cryptogams.

Pycnidia and Stylospores. Pycnidia are dark-coloured conceptacles, found on *Lecidea* and *Scutula,* resembling the perithecia of the *Sphæriæ,* sessile on the thallus, and containing simple filaments (basidia), bearing isolated spores on their apices (*stylospores*).

The so-called spermogonia and pycnidia appear to be in some cases parasitic Fungi.

Chemical reagents are useful in the discrimination of Lichens. Thus, iodine solution will tinge the mature spores or the gelatina hymenea of some Lichens blue, or red without a preparatory blue tinge. Solution of caustic potash produces in the thallus of some Lichens a persistent yellow colour, which in others changes to a red; or if no reaction takes place, solution of chloride of lime produces a red or yellow colour. These reactions must be observed in sections.

The long-known resemblance of the gonidia of Lichens to numerous forms of the lower Algæ, and the similarity of the thecæ of Lichens to the asci of Ascomycetous Fungi, has of late years given rise to the theory (Schwendener's) that the gonidia of Lichens are really Algæ; the Lichens being Ascomycetous Fungi, living and growing upon them as parasites. The Algæ which, according to this view, form the gonidia, are usually species of *Palmella, Protococcus, Nostoc,* &c., rarely of Confervaceæ; and when free, continue to grow and reproduce, still retaining the Alga-form. But when the germinating spores of Lichens come into contact with them, the hyphæ surround the cells, enveloping them, and on further growth a perfect Lichen is formed. This question cannot at present be considered as settled; for while, according to Bornet, the hyphæ never produce gonidia, according to Müller this occurrence most positively does take place. On the whole, it appears that Schwendener's ingenious Lichen-theory will have to be considered one of the modern natural-history romances.

The Lichens are divided into four families:

Byssacei. Thallus byssaceous or finely filamentous, the granula gonima in a thalline sheath.

Collemacei. Thallus gelatinous.

Myrangiacei. Thalamium with cellular cavities, and superimposed theciferous cavities.

Lichenacei. Thallus not gelatinous; variable in colour and form, either filamentous, foliaceous, squamous, or crustaceous; gonidial layer usually distinct.

Bibl. Tulasne, *Ann. Sc. Nat.* 3 sér. xvii., & *Compt. rend.* 1851; Montagne, *Dict. d'hist. nat.* 1846; Itzigsohn, *Bot. Zeit.* viii. & ix.; Flotow, *Flora* and *Bot. Zeit.*; Lindsay, *Pop. Lichens*; Famnitzin and Boranetzky, *Ann. Sci. Nat.* sér. 5, viii.; Leighton, *Brit. Lich. Flora*; Henfrey-Masters, *Bot.*; Nylander, *Lichenogr. Europ.,* & *Flora,* 1879 (*Jn. Mic. Soc.* 1880, 315, *colour*); Reess, *Monatsb. Berl. Ak.* 1871; Bornet, *An. Sc. N.* 1873, xvii.; Schwendener, *Nägeli's wiss. Bot.* 1860, '62, '68, & *Algentyp. Flecht. Gonid.,* 1869; Archer, *Jn. Mic. Soc.* xiii., xiv (*all the papers on*

Schw. Lich.-theory from 1868 *to* 1873); Vines, *Qu. Mic. Jn.* 1878, xviii. 144, 438, *later papers on the same*; Thwaites, *Ann. N. H.* 1877, xx. 386; Frank, *Krust. Flecht., Cohn's Beit.* ii. 123; Stahl, *Entw. d. Flecht.* 1878; Minks, *Flora*, 1878, *Grevillea*, 1879, vii. 89, & *Grenz. zw. Fl. & Pilze*, 1881; Müller, *Ann. N. H.* 1881, viii. 427, & *Grevillea*, x. 87 (*Phillips*); Crombie, *Grevillea*, vii. 143; Cooke, *ibid.* vii. 102, 117.

LICHI'NA, Ag.—A genus of Collemaceous Lichens, allied to COLLEMA and EPHEBE in many respects, formerly included among the Algæ on account of their growing on the sea-shore (near high-water mark), but having the thallus of a lichen and bearing true *apothecia* and *spermogonia*. The globose apothecia occur at the ends of the branches of the thallus; in *L. pygmæa* the spermogonia occur underneath the apothecia, in *L. confinis* at the apices of the branches and often on the apothecia. The spores, 8, simple, appear generally to adhere to the walls of the thecæ, which break up. Spermatia oblong.

BIBL. Greville, *Alg. Brit.* pl. 6; Leighton, *Br. Lich. Fl.* 11.

LICMO'PHORA, Ag.—A genus of Diatomaceæ.

Char. Frustules in front view cuneate, elongate, radiating in a fan-shaped manner from a branched stipes; side view (valves) convex, inflected at the larger end and furnished with transverse striæ (rows of dots). Marine.

L. flabellata, S. (*radians*, K.) (Pl. 17. fig. 3).

The species (one other British, Sm., five in all, Kütz.) are doubtfully distinct.

BIBL. *Br. Diat.* i. 85; Kütz. *Bacill.* 123, and *Sp. Alg.* 113.

LICNO'PHORA, Cl.—A genus of Peritrichous Infusoria; resembling *Trichodina*, but the anterior portion obliquely flattened, and partly involute. Two species, on *Doris*, marine *Planariæ*, &c. (Kent, *Inf.* 651; Clap. *Ann. Sc. N.* 1867, viii.)

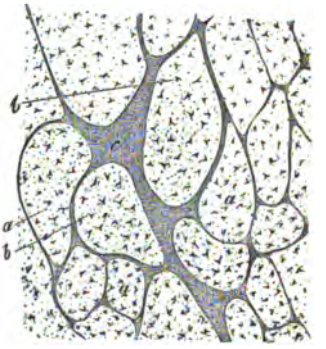
LIEBERKÜH'NIA, Cl. & Lachm.— A genus of Reticularian Rhizopoda. Oviform, with very thin test; nucleus and contractile vesicle unknown; vacuoles present; pseudopodia very long and reticular, branching from a single stem, which is coated with an extension of the filmy sarcode covering the surface. 1 species; fresh water at Berlin, sea-water at Tenby.

BIBL. Clap. & Lachm. *Etudes*, 465; Siddall, *Qu. Mic. Jn.* 1880, 141.

LIEBERKÜHN. INTROD., p. xxi.

LIGAMENTS and TENDONS.—With the exception of the elastic ligaments, which are noticed under that head, the structure of ligaments and tendons is essentially the same. They consist of fibrillar connective tissue, with a small quantity of elastic

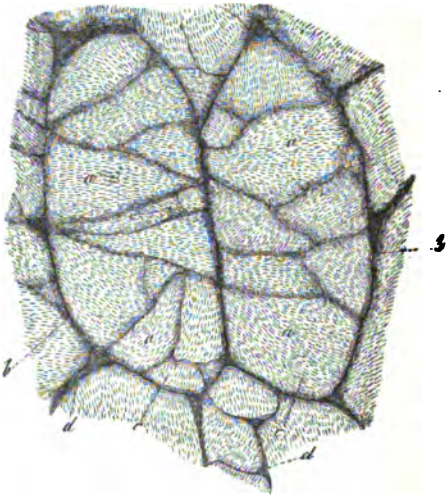
Fig. 399.



Magnified 60 diameters.

Transverse section of the tendon of the tibialis posticus; human: *a*, secondary bundles; *b*, larger nuclear fibres; *c*, interstitial areolar tissue.

Fig. 400.



Magnified 20 diameters.

Transverse section of a tendon of a calf: *a*, secondary, *b*, tertiary bundles; *c*, nuclear fibres, obliquely divided; *d*, interstitial areolar tissue.

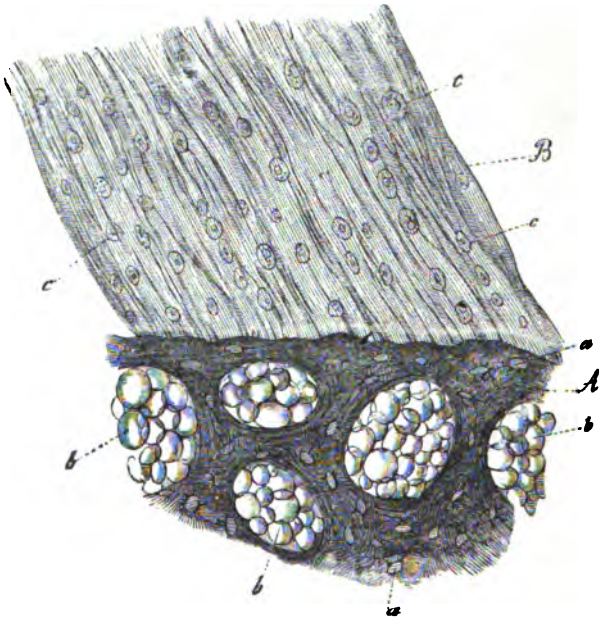
tissue. The fibres or fibrillæ of the connective tissue are very minute, longitudinal, parallel, closely connected, and pursue a straight or undulatory course. Their union into bundles is sometimes very indistinct, and only to be shown by drying transverse sections and afterwards treating them with alkalies. In other instances the bundles are easily recognizable, of a polygonal, rounded or elongated form (fig. 400), and connected by loose interstitial areolar tissue.

The elastic tissue of tendons exists as slender nuclear fibres, sometimes forming rows of narrow spindle-shaped cells connected by slender processes, at others uniform fibres, or isolated spindle-shaped cells. These are placed at regular distances apart, between the bundles of areolar tissue.

When tendons are in contact with bones, they frequently contain cartilage-cells, either isolated or arranged in rows (fig. 401, *c*); these sometimes undergo ossification.

The aponeuroses, fasciæ, and tendinous

Fig. 401.



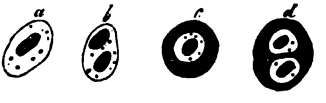
Magnified 300 diameters.

Portion of the tendo Achillis attached to the os calcis; human: *A*, bone with lacunæ *a*, medullary and fat-cells *b*; *B*, tendon with fibrillæ and cartilage-cells *c*.

sheaths consist of the same elements, but in various proportions and differently arranged according to their functions,—sometimes the areolar fibres being predominant, the structure agreeing with that of tendon, whilst at others the elastic tissue is greatly developed (fig. 403). Some of these tissues also contain cartilage-cells.

The intervertebral ligaments consist of fibro-cartilage, surrounded by osseous tissue; the centre is soft and containing concentric cartilage-corpuscles (fig. 101, p. 135).

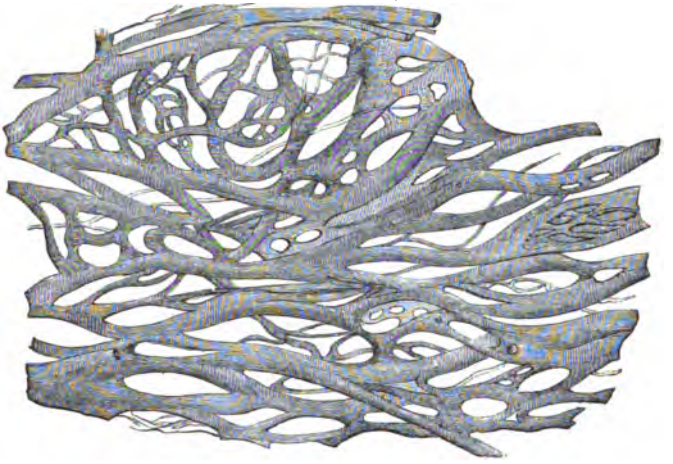
Fig. 402.



Magnified 350 diameters.

Cartilage-cells from the membranous ligament surrounding the popliteus muscle: *a*, cell with one nucleus; *b*, cell with two nuclei; *c*, cell containing one, *d*, two secondary cells, the contents of both of which are more consistent.

Fig. 403



Magnified 450 diameters.

Elastic fibres from the inner part of the fascia lata, human; densely interwoven and forming an elastic membrane.

Bibl. Kölliker, *Mik. An.* i.; Henle, *Allgem. An.*; Donders, *Mulder's Phys. Chem.*; Frey, *Hist.* 240.

LIGNINE.—A modified condition of cellulose is obtained from old wood-cells, and called by this name. It differs in its reactions from pure cellulose, being coloured yellow by sulphuric acid and iodine; but after boiling in nitric acid and washing, tincture of iodine and water give it a blue colour. See Secondary Deposits.

LIMBORIEÆ.—A family of Angiocarpous or closed-fruited Lichens characterized by rounded apothecia closed in by a carbonaceous special perithecium, finally bursting in various ways, containing a somewhat waxy nucleus, which grows hard.

British genera: *Pyrenothea, Strigula.*

LIME, SALTS OF.

Carbonate of lime. This substance is well known as forming chalk, marble, &c., and as occurring in hard animal structures, as bone, shell, &c. It is not unfrequently met with in the form of granules as a component of various animal secretions, as the urine, &c. In this liquid, it sometimes, but rarely, also occurs in little spheres or disks, consisting of groups of radiating needles. This we first found to be the case in human urine (Pl. 13. fig. 8); but it was subsequently detected in that of herbivorous animals, as the cow and the horse (Pl. 13. fig. 7), in which its occurrence is common. It is also a component of otolithes, in which it exists either as granules or minute prisms, often with six sides and trilateral summits. From river- and spring-water it is usually deposited in irregular and imperfect forms (Pl. 13. fig. 6), all of which consist of grouped needles. Sometimes it assumes the rhombohedral form, as in the shell of the oyster (Pl. 45. fig. 10) and frequently in chemical solutions. When treated with a dilute acid, after having been thoroughly washed in a watch-glass, it is dissolved with effervescence from the escape of carbonic acid gas. During the solution it first becomes more transparent, exhibiting the internal crystalline structure, and frequently a concentric or nuclear appearance, which finally disappears. When derived from animal secretions, it leaves undissolved an organic cast of the original, provided the acid be not too strong, or its action too long continued. If the number and size of the minute bodies be relatively very small in proportion to the amount of water, on adding the acid, effervescence will not occur, the water holding in solution the carbonic acid evolved. The presence of the lime may be tested in the ordinary way, by the addition of oxalate of ammonia, when the precipitate is insoluble in acetic acid, or by adding dilute sulphuric acid, when crystalline needles of the sulphate of lime (Pl. 10. fig. 16) are formed.

The spheres or disks naturally occurring

in the urine, are closely imitated by those formed in urine to which chloride of calcium has been added, and which has been subsequently kept for some time.

Lactate of lime may be obtained by acting upon carbonate of lime with lactic acid. It is soluble in water and alcohol. The microscopic crystals consist of tufts of delicate radiating needles (Pl. 11. fig. 19).

Oxalate of lime. This salt exists in solution in the contents of many vegetable cells combined with a proteine compound; it is also probably a normal constituent of the human blood in small quantity, combined and dissolved as in vegetables.

In the cells of plants it is very frequently deposited in a crystalline form, constituting RAPHIDES. From human blood it has been obtained in crystals by treating the alcoholic extract with acetic acid. It is very commonly met with in the crystalline form in various secretions of animals, as the urine, the mucus of the gall-bladder, that of the surface of the pregnant uterus, the liquid of the allantois, the contents of the Malpighian vessels and the so-called true renal vessels of insects, cysts, &c.

Its most characteristic form is the square flattened octahedron (Pl. 13. fig. 9); but it also occurs in the form of the square prism terminated by quadrilateral pyramids, of fine needles, and in that of a flattened body with an ellipsoidal outline, frequently constricted so as to resemble a dumbbell, or variously excavated at parts of the surface (Pl. 13. figs. 11 & 12). It may be obtained artificially in most of these forms (Pl. 13. fig. 13), by dissolving artificial oxalate of lime in dilute nitric acid and evaporating; some of the forms thus obtained resemble those of carbonate of lime. When obtained by mixing oxalate of ammonia with soluble salts of lime, as chloride of calcium, &c., the crystals are generally peculiar (Pl. 13. fig. 14), although sometimes the regular octahedra are obtained.

It is insoluble in hot and cold water, acetic acid and ammonia, but is soluble in dilute mineral acids without effervescence.

Phosphate of lime. This salt is most frequently deposited from animal liquids in an amorphous or granular state. It may be obtained in the crystalline form by mixing a solution of phosphate of soda with chloride of calcium. The crystals are mostly thin rhombic plates (Pl. 10. fig. 17).

They are soluble in acetic and dilute mineral acids without effervescence, but not in potash or water. Some of the compound crystals resemble those of the ammonio-phosphate of magnesia, from which they may be distinguished by the addition of dilute sulphuric acid, which causes the formation of needles of sulphate of lime.

Sulphate of lime. Well known as forming gypsum, alabaster, selenite, &c. It rarely or never occurs in the crystalline form in animal or vegetable products. When rapidly formed in chemical testing, the crystals consist of minute needles or prisms (Pl. 10. fig. 16); when more slowly formed, these are larger and mixed with rhombic plates.

The crystals are but little soluble in water, and not in acetic or the dilute mineral acids. They are sometimes found in bottles containing spirit in which marine animals have been preserved.

Medicinal precipitated sulphur is very commonly adulterated with sulphate of lime. The microscope at once enables the crystals of the salt to be recognized.

Urate of lime. See URATES.

See RAPHIDES and URINARY DEPOSITS.

BIBL. That of CHEMISTRY, ANIMAL.

LIMNAC'TIS, Ktz.—A genus of Rivulariaceæ, Confervoid Algæ.

Char. Filaments pseudo-ramose, subfasciculate, sheath more or less distinct. *L. parvula*; Lincolnshire.

BIBL. Rabenh. *Fl. Alg.* ii. 210.

LIMNADEL'LA, Girard.—A bivalve Phyllopodous Entomostracon, near *Estheria.*

BIBL. Girard, *Proc. Phil. Ac.* i. 184, & vii. 34; Grube, *Wiegm. Arch.* 1865, 73.

LIMNA'DIA, Brongn.—An aquatic bivalved Phyllopod, with thin oval valves, enclosing an elongated body, having a short and a natatory pair of antennæ, oral apparatus, twenty-two or more pairs of branchial lamellæ, and a bifid tail.

BIBL. Brongniart, *Mém. Mus. Hist. Nat.* vi. pl. 13; Desmarest, *Crust.* 378; Milne-Edwards, *Hist. Nat. Crust.* pl. 35. f. 7; Baird, *Zool. Proc.* 1849, 86, pl. 11. f. 1; Grube, *Wiegm. Arch.* 1865, 61, pl. 8; Lereboullet, *Ann. Sc. Nat. Zool.* 5, v. 283, pl. 12.

LIMNE'TIS, Lovén.—An aquatic bivalved Phyllopod, related to *Limnadia* and *Estheria.*

BIBL. Lovén, *K. V. Ak. Handl.* 1845, 203; Baird, *Zool. Proc.* 1862; Grube, *Wiegm. Arch.* 1865, 71.

LIMNIAS, Schrank.—A genus of Rotatoria, of the family Flosculariæa.

Char. Eyes (when young) two, red; ur-

ceoli or sheaths single; rotatory organ with two lobes. Teeth forming a row in each jaw.

L. ceratophylli (Pl. 43. fig. 45). Urceolus at first whitish, subsequently becoming brown or blackish, smooth, or in consequence of its viscidity covered with foreign bodies. Freshwater; length 1-24 to 1-18".

BIBL. Ehr. *Infus.* 401.

LIMNICYTHE'RE, Brady.—An Ostracode, allied to *Cythere*, the antennæ having setæ instead of spines, and the valves being hin, and spinous or tubercled.

BIBL. G. S. Brady, *Linn. Tr.* xxvi. 419.

LIMNOCH'ARES, Latr.—A genus of Hydrachnea (Acarina).

C. aquatica (*holosericea*) (Pl. 6. fig. 27), the only species. It differs from other water-spiders by its walking instead of swimming.

Body very soft and often spontaneously variable in form; epidermis covered with little conical granules (?); no hairs upon the body, and but few upon the legs; eyes attached to a lanceolate scaly piece (*d*), and surrounded by hairs; rostrum partly concealed beneath the skin, the anterior exserted half (*b*) cylindrical and accompanied by the palps, the last joint of which is very slender and obtuse; by pressure the broader base of the rostrum is made to protrude (*f*); tarsi (*c*) thickened at the end, with large claws; coxæ of four posterior pairs of legs longer than the others, which is contrary to what occurs in *Hydrachna*, *Atax*, &c.; coxæ of the two anterior pairs of legs closely approximate, as are also those of the two posterior pairs (*e*); but the two groups are widely separated.

Larvæ with six legs, a large head-like rostrum, with two large palps and two black lateral anterior eyes, fixing themselves on the head of *Gerris lacustris*; they subsequently detach themselves, fall into the water, and pass their nymph-stage under submersed stones, the perfect animal making its appearance at the end of fifteen days.

BIBL. Dugès, *Ann. Sc. Nat.* 2 sér. i. 159; Gervais, *Walckenaer's Arachn.* 208; Koch, *Deuts. Crustac.*

LIMNODIC'TYON, Kütz.—A genus of Protococcaceæ.

Char. Cells angular from mutual pressure, forming membranous layers, in a parenchymatous form; multiplication by gonidia.

L. Rœmerianum (Pl. 52. fig. 14), in pools.

BIBL. Rabenh. *Fl. Alg.* iii. 61.

LIMNO'RIA, Leach.—A genus of marine Crustacea, Order Isopoda, and family Asellota.

L. terebrans (Pl. 36. fig. 27) is of interest on account of the great ravages which it commits in submerged timber, as the piles of piers, flood-gates, docks, &c., which it perforates in every direction. Head large, rounded; antennæ four, of nearly equal length; eyes two, lateral, black, composed of about seven ocelli; body elongato-subcylindrical, thorax with seven joints, legs seven pairs, formed for walking; abdomen six-jointed, the last joint large, suborbicular, and with two styles; length about 1-6". It contracts into a ball when disturbed.

BIBL. Leach, *Linn. Tr.* xi. 370; Coldstream, *Edin. New Phil. Jn.* 1834; Dalyell, *Wonders of Creation*, i.

LINDIA, Duj.—A genus of Rotatoria, of the family Hydatinæa, E. (Furcularina, Duj.).

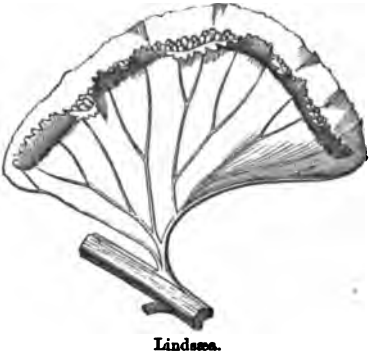
Char. Body oblong, almost vermiform, with transverse folds, rounded in front, but no rotatory organ, cilia, or eye; tail-like foot with two conical and short segments or toes; jaws very complicated (and imperfectly described).

L. torulosa (Pl. 43. fig. 40). Freshwater; length 1-75".

BIBL. Duj. *Infus.* 653; Cohn, *Sieb. & Köll. Zeit.* 1858, 286; Pritch. *Infus.*

LINDSÆA, Dryander.—A genus of Lindsayeæ (Polypodiaceous Ferns). Exotic (fig. 404).

Fig. 404.



Lindsæa.
A pinnule. Magn. 10 diams.

LINGULI'NA, D'Orb.—A hyaline stichostegian Foraminifer, differing from *No-*

dosaria in being laterally compressed and having a slit-like aperture.

Bibl. Carpenter, *Introd.* 163.

LINGULINOP'SIS, Reuss.—This may be defined as a *Lingulina* having its early chambers coiled; or a *Marginulina* much compressed and opening with a rift.

Bibl. Reuss, *K. böhm. Ges. Wiss.* 1860.

LINOP'ODES, Koch.—A genus of Trombidina (Acarina); with the legs 6-jointed, the anterior pair very long and slender. Three species; among moss; red or orange. (Murray, *Ec. Ent.* 122; Hermann, *Apter.*)

LI'NUM, L. See Flax.

LIOSI'PHON, Ehr.—A genus of Holotrichous Infusoria, fam. Trachelina.

Char. Resembles *Nassula*, but the frontal region prolonged. 1 species.

Bibl. Pritchard, *Infus.* p. 627.

LIOSTEPHA'NIA, Ehr.—A genus of Melosireæ (Diatomaceæ).

Char. Frustules single, orbicular; disk smooth, but with a crown of rays round a smooth space; 3 species; Barbadoes.

L. rotula (Pl. 51. fig. 17).

Bibl. Pritchard, *Infus.* p. 813.

LIOTHE'UM, Nitzsch.—A genus of Anoplura, family Liotheidæ.

Char. Antennæ clavate or capitate; maxillary palpi conspicuous; mouth with strong mandibles; tarsi with two claws.

Antennæ four-jointed; mandibles with two teeth; maxillary palpi long, filiform, four-jointed; labial palpi very short, two-jointed.

The genus has been subdivided into seven subgenera. The species are very numerous, and are parasitic upon birds.

L. (*Menopon*) *pallidum* (Pl. 35. fig. 7). Elongate, of a pale straw-colour, shining and smooth; head slightly sinuate on each side, with a dark pitchy spot before each eye. Length 1-24 to 1-16". Common on the domestic fowl. Other species on the partridge, pheasant, and quail.

Bibl. Denny, *Monogr. Anoplur.* p. 204.

LIPAROGY'RA, Ehr.—A genus of Melosireæ (Diatomaceæ).

Char. Frustules simple, cylindrical, each having an internal spiral filiform band or crest.

Bibl. Pritchard, *Infus.* p. 823.

LIPEU'RUS, Nitzsch.—A subgenus of *Philopterus*. The species are found on the pigeon, the goose, the fowl, and the turkey.

Bibl. Macalister, *Qu. Micr. Jn.* 1871, 163; Murray, *Ec. Ent.* 381; Mégnin, *Paras.* 88.

LIRADIS'CUS, Grev.—A genus of Diatomaceæ.

3 species; Barbadoes deposit. *L. Barbadensis* (Pl. 52. fig. 13).

Bibl. Greville, *Tr. Mic. Soc.* 1865.

LISTROPH'ORUS, Pagenst.—A genus of Acarina, allied to *Sarcoptes*. Two species, on field-mice, rabbits, and the ferret, the partridge, &c. The maxillæ form two flexible claspers, for clinging to the hairs. (Pagenstecher, *Zeits. wiss. Zool.* xi. 156; Murray, *Econ. Ent.* 324.)

LITHIC ACID. See Uric Acid.

LITHOCYS'TIS, Allm.—A genus of Corallinaceæ (Florideous Algæ), consisting of a single species, *L. Allmanni*, Hass., which has been found as an epiphyte, forming minute white dots upon *Chrysimenia clavellosa*. The minute dots consist of one or more fan-shaped fronds composed of square cells. The plant is colourless, brittle, and effervesces in acid. The fan-shaped frond somewhat resembles in structure imperfect or segmental fronds of Coleochæte.

Bibl. Harvey, *Mar. Alg.* 111, pl. 14 B; *Phyc. Brit.* pl. 166.

LITHODES'MIUM, Ehr.—A doubtful genus of Diatomaceæ. Marine.

L. undulatum (Pl. 17. fig. 4 *a*, front view; 4 *b*, side view). Surface without markings, very pellucid, two of the sides undulate, the third plane and with two marginal notches; angles obtuse; length of joints 1-480".

Bibl. Ehr. *Abh. d. Berl. Akad.* 1840; Kütz. *Bacill.* p. 135, and *Sp. Alg.* p. 133.

LITHOFELLINIC ACID.—Is a component of certain concretions called bezoars, found in the alimentary canal of various kinds of goat in Persia &c.

It is crystalline, insoluble in water, readily so in hot alcohol, but little in ether.

The perfect crystals form six-sided prisms with truncated ends; but when somewhat rapidly deposited from an alcoholic solution, they are modified as represented in Pl. 11. fig. 14. With Pettenkofer's test they are turned red.

LITHOG'RAPHA, Nyl.—A genus of Graphidei (Lichenaceous Lichens).

Char. Thallus crustaceous or evanescent; apothecia lirellæform, black, tumid; epithecium rimiform, margins thick, convex; hypothecium black, thick, entire; spores 8 or numerous, simple or 1-septate.

7 British species. Rare.

Bibl. Leighton, *Brit. Lich. Flor.* p. 393.

LITOSI'PHON, Harv.—A genus of Punctariaceæ (Fucoid Algæ), with fronds

composed of cartilaginous filiform unbranched filaments, at first solid, afterwards tubular, composed of several rows of cells; epiphytic on *Chorda filum* (*L. pusillus*) and *Alaria* (*L. Laminariæ*), the former 2 to 6″ long, the latter 1-4 to 1-2″. The sporanges occur either solitary or aggregated, scattered on the surface of the filaments, which in *L. pusillus* are clothed with pellucid hairs, in *L. Laminariæ* smooth.

Bibl. Harv. *Mar. Alg.* p. 43, pl. 8 D; Thuret, *Ann. Sc. Nat.* 4 sér. iii. p. 14.

LITU'OLA, Lamarck.—A protean Foraminiferal genus, abundant both recent and fossil; characterized by the test being coarsely arenaceous, with little or no calcareous cement. The shell may be unilocular (*Proteonina*?, Williamson). If compound, its shape may be loosely moniliform (*Reophax*, Montfort), whether straight, coiled, or irregular, free or attached (the latter feature characterizing *Placopsilina*, D'Orb.). Or the chambers may be close-set and overlapping, and have either a straight, coiled, or crozier-like contour, imitating various forms of other Foraminifera, such as *Orthocerina*, *Nodosaria*, *Flabellina*, *Cristellaria*, *Spirolina*, *Rotalia*, *Nonionina*, *Globigerina*, *Orbulina*, &c. Further, the chambers may communicate by a simple central aperture, or by a cribriform septal plate; and they may be either simply hollow, or labyrinthic from secondary growths. Some with a single aperture and undivided chambers, and some which are labyrinthic and cribriform, belong to Reuss's *Haplophragmium* and *Haplostiche* (straight). When the aperture is of a horse-shoe shape and subvalvate, we have the allied *Hippocrepina*, Parker. Pl. 23. fig. 18 is an irregularly nautiloid, labyrinthic form (*Lituola difformis*) very common in the Chalk.

Bill. Carpenter, *Introd.* p. 143.

LITUO'LIDA, Carp. = Lituolidæ and Astrorhizidæ, p. 332. — Besides the coarse-grained genus *Lituola* (with its subdivisions), there are several closely related forms which differ chiefly in the degrees of smoothness and compactness with which the constituent sand-grains, and sometimes spicula, are set and cemented.

Botellina, Carpenter, is a long, roughly segmented tube of sand and spicules, with ill-defined terminal aperture. *Saccammina*, Sars, is spherical and smooth, either single or in twos or threes united by a narrow stolon-tube. This is found fossil in the Lower Carboniferous strata, as well as recent. *Pilulina*, Carpenter, quite spherical, with a fissure-like mouth, is composed of very fine sand and points of spicules. *Astrorhiza*, Sandahl, relatively large, has a coarse, irregularly stellate, test of loosely aggregated sand, with pseudopodial apertures among the granules, chiefly at the ends of the digitate radii. *Rhadammina*, Sars, arenaceous, with a cement containing ferric phosphate, is tubular, forked, or radiate, usually trifid, with a central cavity; openings at the radial ends.

The *Lituolida* with fine-grained and smooth tests are best typified by *Trochammina* and its subgenus *Webbina* (D'Orb., restricted). These range from simple, attached, tent-like, single or multiple tests (*W. hemisphærica*, *W. irregularis*, &c.), to the tubular and spiral *Troch. incerta* (Pl. 23. fig. 14) and the rotalioid *T. squamata* et *inflata*. The rotalioid and fusuline *Endothryæ* and the nummulitoid *Involutina*, all fossil, belong to the same category.

Valvulina, one of the Textulariidæ, sometimes finely, sometimes coarsely arenaceous, is, in this character, allied to the Lituolines and Trochammines; and among its several modifications some link it with *Lituola* and others with *Trochammina*. *Tetrataxis* has an alternation of *four*, and *Valvulina* (Pl. 23. fig. 20) of *three* chambers.

The *Lituolida* are represented in every existing sea, and in every geological formation as far back as the Carboniferous.

Bibl. Carp. *Introd.* 140; *Descr. Cat. Mic. Soc.* April 1870, 4; Parker, Jones, and Brady, *Phil. Tr.* clv. 406; *Monogr. Crag For.*, *Pal. Soc.* 25; Brady, *Mon. Carb. For.*, *Pal. Soc.* 1876; *Qu. Mic. Jn.* n. s. xxi.

LIVER.—The glandular organ which secretes the bile.

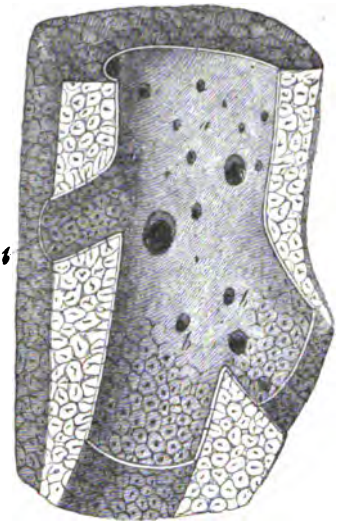
On examining the surface or a transverse section of the liver with the naked eye, it usually presents a mottled appearance, numerous spots of a dark or light red colour being surrounded by a margin of a paler or darker colour. These spots correspond to the lobules of the liver.

The lobules are rounded or polygonal, and about 1-2 to 1‴ in diameter (fig. 405).

Between the lobules run branches of the vena portæ, forming the interlobular veins (coloured red in Pl. 39. fig. 33); these throughout their course send off numerous smaller branches into the substance of the lobules, which terminate in the capillary plexus of the lobules.

The branches of the vena portæ are accom-

Fig. 405.



Magnified about 3 diameters.

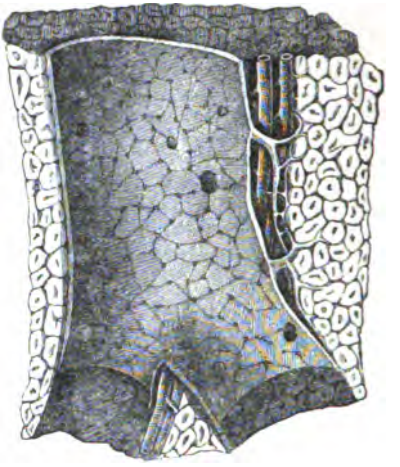
Portion of the liver of a pig, with divided branches of the vena cava; the lobules are visible upon the divided surfaces: *a*, large vein, no orifices of the intralobular veins being visible; *b*, branches of the same, with distinct orifices of the intralobular veins, and the bases of the lobules seen through their walls.

panied by branches of the hepatic duct and ramifications of the hepatic artery, the whole being surrounded by connective tissue prolonged from Glisson's capsule. Hence, in a section of the uninjected liver, those branches of the vena portæ and of the vena cava which are visible to the naked eye are readily distinguishable from each other by the orifices of the former collapsing, whilst those of the latter are kept open by their close contact with the lobules.

In the centre of each lobule arises a branch of the vena cava, by the union of numerous smaller branches (coloured yellow in Pl. 39. fig. 33), which take their origin in the capillary plexus of the lobule; these central branches form the intralobular veins.

The capillaries of the lobules form a close and elegant plexus between the branches of the inter- and intralobular veins, the rest of the lobules being filled up with the secreting cells.

Fig 406.

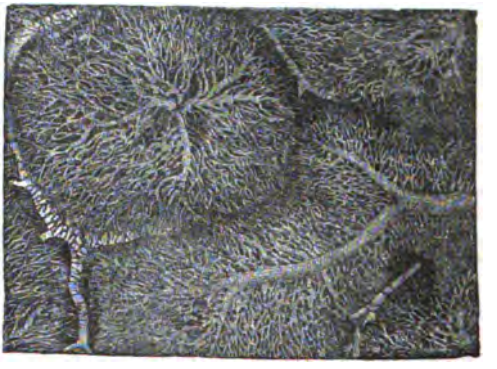


Magnified about 4 diameters.

Section of the liver of a pig through a branch of the vena portæ, with accompanying branches of the hepatic artery and duct. On the right are seen two branches of the vena portæ giving off the interlobular veins.

The branches of the biliary ducts accompany those of the vena portæ as far as the interlobular spaces, where they again branch off, forming a network of extremely slender tubes or biliary capillaries, which surround individually the liver-cells (fig. 408). The biliary ducts consist of an outer coat of connective tissue, the bundles of fibres of

Fig. 407.

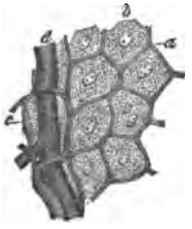


Magnified 35 diameters.

Section of a portion of the liver of a rabbit, showing the entire course of one of the intralobular veins, the roots only of the others.

which are difficultly separable, and an internal epithelial layer. The former is most distinct in the larger branches, being almost absent in the terminal interlobular ducts; it contains numerous nuclei and nuclear fibres. Kolatschewsky states that the bile-ducts are directly continuous with the cavity of the liver-cells. The epithelium

Fig. 408.



Magnified 200 diameters.

Biliary capillaries from the liver of the rabbit: *a*, biliary capillaries; *b*, liver-cells; *c*, bile-ducts; *d*, capillary blood-vessel.

of the larger ducts is cylindrical, that of the smaller of the pavement kind. In the hepatic ducts, the outer coat contains scattered muscular fibre-cells. The ducts also contain small mucus-glands. The secreting cells of the lobules fill up the interspaces between the blood-vessels. They are very transparent, of a rounded or polygonal form, about 1-1000″ in diameter, containing one or two nuclei, with a very fine reticulum and a number of granules, and a few small globules of fat (fig. 160, page 238).

Kupffer describes star-cells existing within the liver-cells, after staining with chloride of gold.

The division of the substance of the liver into lobules is rather apparent than real, being effected by the peculiar arrangement of the vessels, the lobules having no true coat or envelope.

The connective prolongation of Glisson's capsule which accompanies the vena portæ and its branches becomes less and less in quantity as the branches become smaller, and is apparently lost in the interlobular spaces. It is much more abundant in animals, as the pig, than in man, rendering the lobular arrangement much more distinct. But, after washing away the liver-cells with a hair-pencil, from a thin section, a very delicate network, consisting of a homogeneous membrane with minute nuclei, remains, in the meshes of which the liver-cells are placed.

The branches of the hepatic artery are distributed to the portal vessels, the hepatic ducts, Glisson's capsule with its prolongations, and the peritoneal coat. They are often elegantly tortuous.

Among the more common morbid states of the liver may be mentioned:—that called cirrhosis, in which the connective tissue is excessively developed and mixed with a large number of fibro-plastic corpuscles, producing an atrophied state of the epithelial structure; the amyloid degeneration, which commences between the inter- and intra-lobular portions, in the branches of the hepatic artery; an increase in the amount of fatty matter in the cells (fig. 160, page 238); and the presence in these also of granules of cholepyrrine, rarely with crystals of cholesterine and bilifulvine.

The examination of the arrangement of the blood-vessels is best made in a liver which has been injected with two kinds of injection, as yellow (chromate of lead) and red (vermilion), or red and white (carbonate of lead)—the yellow or white being injected into the hepatic vein. As the injection is being proceeded with, the surface of the liver should be examined with a lens to ascertain whether the intralobular veins are well filled, and the injection has reached the capillaries; the red injection should then be thrown into the portal vein until it is filled. The general vascular arrangement is best observed in an injection in which the capillaries themselves are not filled, but only the smaller portal and hepatic branches.

To examine the ducts as to their course and termination, the portal vein should previously be injected. If this be not done, the injection easily bursts through the walls of the terminal ducts, and escapes into the intralobular plexus; and thus the appearance of a plexus of vessels prolonged from the terminal ducts is produced. The fine ferridcyanide cold injection should be used.

The structure of the hepatic cells is easily seen on scraping the surface of a section of the liver, and placing the portion thus obtained between two pieces of glass as usual.

The minute structure of the liver is best seen in sections of portions which have been hardened in chromic acid or spirit, and stained with logwood. In these, the cut orifices of the biliary capillaries are sometimes seen, between the liver-cells.

The general arrangement of the secreting cells is observed in sections made with Valentin's knife.

In many animals, as fishes, the loading of the cells of the liver with fat, which in man represents the morbid state of fatty degeneration, is normal, and renders it a matter of some difficulty to distinguish clearly the outlines of the cells, which are also very delicate.

Bibl. Kiernan, *Phil. Tr.* 1833; Kölliker, *Mik. Anat.* ii.; H. Jones, *Phil. Tr.* 1846, and 1849; Guillot, *Ann. Sc. Nat.* 1848; Leidy, *Sill. Jn.* 1848; *Beale, Liver, & How*; Hering, *Stricker's Gewebel.* i. 429; Kolatschewsky, *Sch. Arch.* 1877, xiii. 415; Frey, *Hist.* 540.

LLA'VEA, Lagas.—A genus of Pterideæ (Polypodiaceous Ferns). One species; Mexico. (Hooker, *Syn. Fil.* 144.)

LOASA'CEÆ.—A family of Dicotyledonous Flowering plants, with stinging hairs upon the epidermis. *Loasa, Bartonia,* and *Blumenbachia* are often to be obtained in gardens.

LOCUST-BEANS.—The seeds of *Ceratonia siliqua* are so called.

LOFTU'SIA, H. B. Brady.—A large fusiform arenaceous Foraminifer, consisting of a spiral lamina, secondary oblique longitudinal septa, and tertiary vertical divisions, making the internal structure labyrinthic. In texture similar to the higher *Trochamminæ, Loftusia* stands high amongst the arenaceous forms, corresponding with *Alveolina* in the Porcellaneous, and *Fusulina* in the Hyaline group. Fossil in Persia.

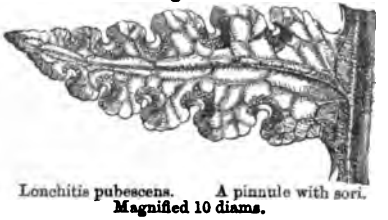
Bibl. Brady, *Phil. Trans.* 1869, 751.

LOMA'RIA, Willd.—A genus of Pterideæ (Polypodiaceous Ferns).

L. Spicant, often called *Blechnum boreale*, is British. Many other foreign species. (Hooker, *Syn.* 174.)

LONCHI'TIS, Presl.—A genus of Pterideæ (Polypodiaceous Ferns). Differs from *Pteris* in the sori occupying the sinus; exotic (fig. 410). (Hook, *Syn.* 128).

Fig. 410.



Lonchitis pubescens. A pinnule with sori.
Magnified 10 diams.

LO'PHIUM, Fr.—A genus of Pyrenomycetes (Ascomycetous Fungi), remarkably distinguished by the form of the *perithecia* resembling a bivalve shell with the valves *in situ* (figs. 411 & 412). The nucleus contained within the carbonaceous

Fig. 411. Fig. 412. Fig. 413.

Lophium mytilinum.
Fig. 411. A perithecium, seen sidewise.
Fig. 412. The same, seen endwise.
Fig. 413. A perithecium cut open.
Magn. 25 diams.

perithecium consists of erect asci mixed with paraphyses, containing minute spores, and soon falling away into a powder. *L. mytilinum*, Pers. (figs. 411–13), occurs on the bark or naked wood of fir trees. *L. elatum*, Carm., also occurs on fir wood.

Bibl. Berk. *Br. Fl.* ii. pt. 2. 280; Fries, *Syst. Myc.* ii. 533; *Summa Veg.* 401; Greville, *Sc. Crypt. Fl.* pl. 177.

LOPHOCO'LEA, Nees.—A genus of Jungermannieæ (Hepaticæ), including *J. bidentata*, L., and *J. heterophylla*, Schrad., growing in moist situations, at the roots of trees, &c.

Bibl. Hook. *Brit. Jungerm.* pls. 30, 31 *Br. Fl.* ii. pt. 1. 122.

LOPHO'MONAS, Stein.—A genus of Flagellate Infusoria.

Char. Free, ovate, spherical or fusiform, with an anterior tuft of long slender flagella.

Two species; intestines of *Blatta*, &c. (Kent, *Inf.* 321.)

LOPHOPH'ORUS, Br.—A genus of Copepodous Entomostraca.

L. insignis. In marine dredgings, Durham. (Brady, *Copep., Ray Soc.* i. 121.)

LOPHOPO'DIUM, Ktz.—A doubtful genus of Oscillatoriaceæ, allied to *Amphithrix*. 6 spec., on submerged stones and posts.

Bibl. Rabenh. *Fl. Eur. Alg.* ii. 231.

LOPH'OPUS, Dumortier.—A genus of freshwater Polyzoa, of the order Hippocrepia, and family Plumatellidæ.

Char. Polypidom sacciform, hyaline, gelatinous, with a disk serving for attachment;

orifices scattered; ova elliptical, with a ring, but no spines.

Bibl. Allman, *Fresh. Polyzoa* (*Ray Soc.*), 83; Johnston, *Brit. Zooph.* 391.

LORI'CA. See Carapace.

LOUSE. See Pediculus and Anoplura.

LOVENEL'LA, Hincks.—A genus of Campanulariidæ (Hydroid Zoophytes).

Char. Stems simple or slightly branching, rooted by a thread-like stolon; capsules turbinate, elongate, operculum of distinct segments; proboscis large and prominent. *L. clausa*, in dredgings, Torbay.

Bibl. Hincks, *Brit. Hyd. Zooph.* 177.

LOXOCEPHA'LUS, Eberh.—A genus of holotrichous Infusoria.

Char. Free, ovate-oblong, constricted towards the front, with one or more short setæ at the constriction, and one or more caudal setæ.

Two species. Freshwater, with decaying vegetation. (Kent, *Inf.* 488.)

LOXOCON'CHA, Sars.—A marine Ostracode, allied to *Cythere*, with long setiferous antennæ, and strong subrhomboidal valves, which have toothed hinges and often a pitted surface. Common in the British and other seas, and fossil in the Tertiary and post-Tertiary strata.

Bibl. Brady, *Linn. Tr.* xxvi. 432.

LOXO'DES, Ehr.—A genus of hypotrichous Infusoria, family Trachelina.

Char. Body curved, with a longitudinal row of transparent vesicles, each of which contains a highly refracting body, and with a more or less arborescent distribution of the digestive canal.

L. rostrum, Ehr., *Pelecida rostrum*, Duj. (Pl. 31. fig. 39); freshwater.

L. bursaria (Pl. 31. fig. 41) is a Paramecium. *L. cucullulus* and *L. dentatus* belong to *Chilodon*.

Bibl. Ehr. *Inf.* 323; Duj. *Inf.* 449; Stein, *Inf.*; Claparède et Lach. *Inf.* 339.

LOXOPHYL'LUM, Duj.—A genus of holotrichous Infusoria, fam. Trachelina.

Char. Body flat and leaf-like; contractile vesicle posterior, near the anus; anterior part of the body sometimes produced. 5 species. *L. fasciola* (Pl. 30. fig. 10). They belong to the genera *Amphileptus* and *Trachelius*, Ehr.

Bibl. Duj. *Infus.* 487; Claparède et Lachmann, *Infus.* 360; Kent, *Inf.* 527.

LOXOSO'MA, Keferst. — A genus of Polyzoa, fam. Pedicellinidæ. Like *Pedicellina*, but united in colonies. 3 species, on marine annelida. (Hincks, *Polyz.* 572.)

LOXSO'MA, Brown.—A genus of Hymenophylleæ (Polypodiaceous Ferns), distinguished by the projecting column bearing the sporangia (figs. 414, 415, 416).

Fig. 414.

Fig. 415.

Fig. 416.

Loxsoma Cunninghamii.

Fig. 414. A pinnule with marginal sori. Magn. 5 diams.
Fig. 415. A sorus opened. Magn. 25 diams.
Fig. 416. Columella with sporanges. Magn. 50 diams.

New Zealand (Hooker, *Syn.* 56).

LUCERNARIA, Fabricius.—A genus of Medusæ. *L. auricula* is common in the summer in the seas of England and Norway. It can be kept for some time in an aquarium, and from the small size of many individuals, is a very interesting object for the microscope.

Bibl. M.-Edwards & Haime, *Corall.* iii. 457; Agassiz, *Sea-side Stud.*, 1871, 46; Keferstein, *Zeit. f. wiss. Zool.* xii.

LUMBRI'CUS.—A genus of setigerous Annulata. *L. terrestris*, the earthworm. Ray Lankester, *Qu. Mic. Jn.* 1864 & 1865; Lockhart Clarke, *Proc. Roy. Soc.* 1857, 344 (*nervous system*); Rolleston, *Forms of An. Life.*

LUNGS.—The internal respiratory sacs of animals.

Under this head we shall notice also the larynx, trachea, and bronchi.

Larynx.—The cartilages of the larynx do

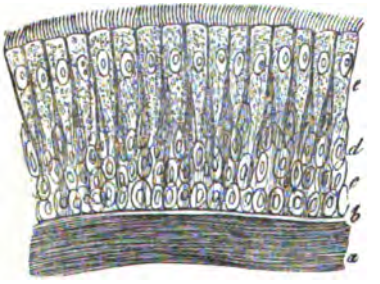
not all possess the same minute structure. The thyroid and cricoid cartilages consist of hyaline cartilage, the basis being homogeneous, and containing disseminated cartilage-corpuscles. The walls of the corpuscles are usually thick. The basis often becomes fibrous, and both corpuscles and basis incrusted with calcareous salts, or completely ossified. Their perichondrium is firm, and is composed of connective tissue, with fine elastic fibres, vessels, and nerves.

The epiglottis (Pl. 49. fig. 40) and the appendices of the arytenoid consist of fibro-cartilage; and the corpuscles are frequently more or less filled up by secondary deposit.

The mucous membrane, as also the submucous tissue of the larynx, consists of connective tissue with networks of fine elastic fibres; at the surface it becomes more homogeneous, but does not form a separable basement layer or membrane. It contains a number of small racemose glands, the vesicles of which are lined with pavement, the ducts with cylindrical epithelium. Its surface is covered with ciliated epithelium, agreeing in structure with that of the trachea.

Trachea and larger bronchi.—The incomplete cartilaginous rings of these tubes are surrounded and connected together by a firm, elastic, fibrous membrane, forming their perichondrium, which also covers the

Fig. 417.



Epithelial cells of the trachea *in situ*; human. *a*, longitudinal elastic fibres; *b*, homogeneous outer (basement) layer of the mucous membrane; *c*, deep layers of round cells; *d*, intermediate layers; *e*, outer ciliated cells.

Magn. 350 diameters.

posterior part of the tubes as a somewhat thinner layer. The cartilage is of the true kind. At the posterior part of the tubes is a layer of unstriated muscular fibres, most of which form transverse, but a few longitudinal bundles. The elastic tissue of the mucous membrane is greatly developed, forming a distinct internal layer of principally longitudinal anastomosing fibres.

The epithelium is ciliated, and consists of several layers. The deepest layers are composed of roundish cells with distinct nuclei, those succeeding being elongated, while those next the surface are still longer, greatly narrowed at the base, and with oval nuclei. Those of the last row are covered with vibratile cilia (fig. 418).

The *smaller bronchi* differ in structure somewhat from the larger. Thus, the cartilage forms angular plates distributed throughout their circumference, while the elastic and connective-tissue coats become thinner, and the transverse muscular fibres smaller and less closely placed.

Fig. 418.

Isolated epithelial cells from the surface of the trachea; human. Magnified 350 diameters.

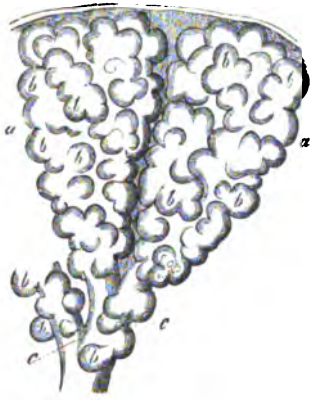
Air-cells. The terminal bronchi open into a group of air-cells partly fused together, forming common cavities—the lobules, alveoli, or infundibula. These are separated from each other by connective tissue mixed with muscular fibres, containing, in adult animals, black pigment in the form of granules, sometimes also crystals. They are best seen in the lungs of young animals.

The walls of the pulmonary air-cells consist of a fibrous, and an epithelial layer. The former is composed of a basis of homogeneous connective tissue, with numerous elastic fibres, vessels and nerves.

The elastic fibres surround the air-cells in the form of elegant wavy bundles and separate fibres, which anastomose and constitute a dense network, most obvious at those parts where several cells are in contact with each other; while in other parts the areolar element supporting the numerous capillaries predominates, and the elastic elements are more sparing and slender. The epithelium is of the pavement kind, not ciliated, consisting of rounded or polygonal nucleated cells, about $\frac{1}{1000}''$ in diameter.

The smaller or primary lobules are aggregated to form larger secondary lobules—the lobules of descriptive anatomists, and

Fig. 419.

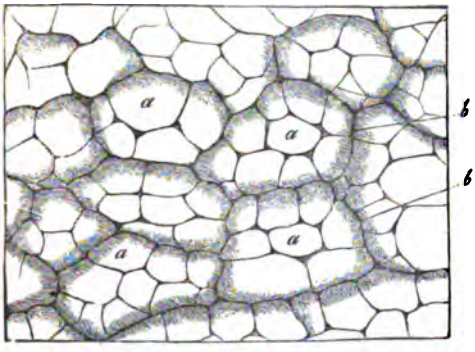


Two pulmonary lobules *a a*, with the air-cells *b b*, and the terminations of the bronchi *c c*; from an infant newly born.

Magnified 25 diameters.

the outlines of which in adults are also principally mapped out by lines of pigment.

Fig. 420.



Outer surface of the lung of a cow, the air-cells of which are injected with wax: *a*, *a*, *a*, air-cells; *b*, *b*, boundaries of the (primary) lobules.

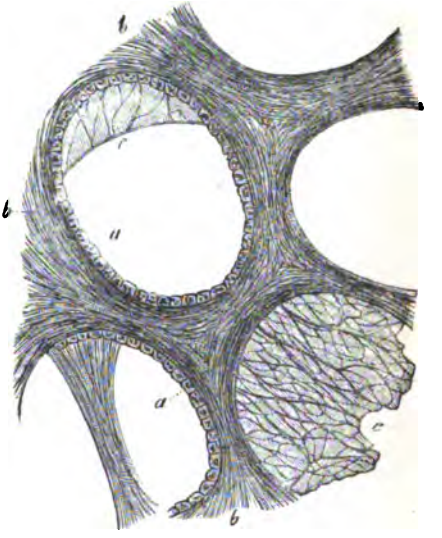
Magnified 30 diameters.

The lobular structure of the lungs is best shown in the lungs of fœtal animals injected from the trachea or bronchi.

The capillaries of the lungs are extremely minute and very difficult to inject fully; and the finest injection is required for the purpose.

The capillaries may often be well seen in thin sections of the inflated and dried organs. The altered structure of emphysematous lungs may also be best shown by this method.

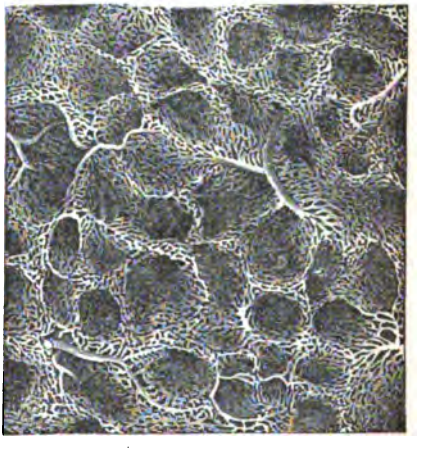
Fig. 421.



Air-cells of a human lung. *a*, epithelium; *b*, fibrous portion, where the walls of several air-cells are confluent; *c*, thinner walls of several air-cells.

Magnified 350 diameters.

Fig. 422.



Capillaries of the human lung.

Magnified 60 diameters.

The epithelium is best seen in sections of

a lung which has been injected from the trachea with a very weak solution of nitrate of silver; or in well-washed sections treated with very dilute acetic acid; solution of logwood is useful for staining.

The lymphatics invest the subpleural lobules in the form of a plexus, and dip inwards to join the deep-seated tubes which accompany the bronchi and large vessels to the root of the lung.

In the lower vertebrate animals, the structure of the lungs is much simplar than in the higher. Thus in the *Triton* each forms a simple tubular sac, whilst in the frog and toad (Pl. 39. fig. 34) each lung may be compared to a single lobule of a lung of the Mammalia, having a cavity in the centre, with which comparatively few large cells extending into the periphery communicate. The capillaries are also much larger, especially in the two animals last mentioned.

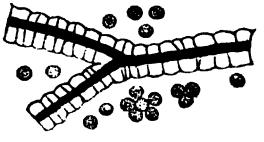
Bibl. Kölliker, *Mik. An.* ii.; Stannius, *Vergl. An.*; Waters, *Human Lung*, 1860; Verson and Schulze, *Stricker's Hist.* i.; Williams, *Todd's Cycl. An.*; Luschka, *Archiv mik. Anat.* v. 1; Frey, *Hist.*, and the Bibl.

LUNULA'RIA, Michel.—A genus of Marchantieæ, growing on the ground in shady places, having the perigones spreading like rays from the top of the receptacle (figs. 319, p. 387, 329–331, p. 389), which is a mere peduncle, so that an approach is made to the character of the Jungermannieæ. See Hepaticæ.

LYCOG'ALA, Mich.—A genus of Myxomycetes, consisting of somewhat globular bodies, verrucose on the outside, composed

Fig. 422*.

Lycogala epidendrum. Natural size.



Filament and spores of the same. Magn. 200 diams.

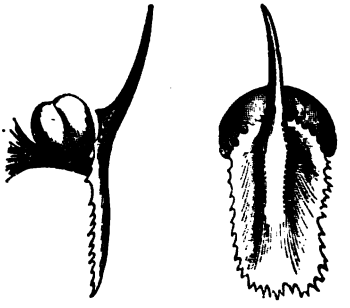
of a double papery peridium, containing capillitium and spores, growing on rotten wood, &c. *L. epidendrum* (fig. 422*) varies from the size of a pea to that of a nut, is globular when solitary, deformed when growing in groups, and of a red colour. *L. parietinum* is bluish black, and the peridia do not exceed 1-20″ in diameter.

Bibl. Berk. *Br. Fl.* ii. pt. 2. 307; *Ann. N. H.* 2 ser. v. 365; Grev. *Sc. Crypt. Fl.* pl. 38; Fries, *Syst. Mycol.* iii. 79; *Summ. Veg.* 448.

LYCOPER'DON, Mich.—A genus of Trichogastres (Gasteromycetous Fungi). The species are commonly known as puff-balls, from the cellular matter being absorbed, leaving the spores free, mixed with a few threads, and discharged like a puff of smoke. The structure of the hymenium is noticed under Gasteromycetes; see also Pl. 27. fig. 6. The ignited mass of spores and threads forms an anæsthetic.

LYCOPODIA'CEÆ. — This order of Cormophytous Flowerless Plants, which derives its name from the *Lycopodia* or Club-mosses, is difficult to characterize in general terms. The bifurcating branched stem, rooting at each fork by a slender thread-like adventitious root, and the ordinarily small overlapping leaves, distinguish most of the species of *Lycopodium*; but there is considerable variation from this habit in the *Psilotea*, especially in *Isoëtes*, and the nature of the fructification is the only mark generally applicable. The Lycopodiaceæ bear spores which are found in small dehiscent cases at the bases of the

Fig. 423. Fig. 424.



Lycopodium Gayanum.

Fig. 423. Scale of spike with axillary sporange; side view.

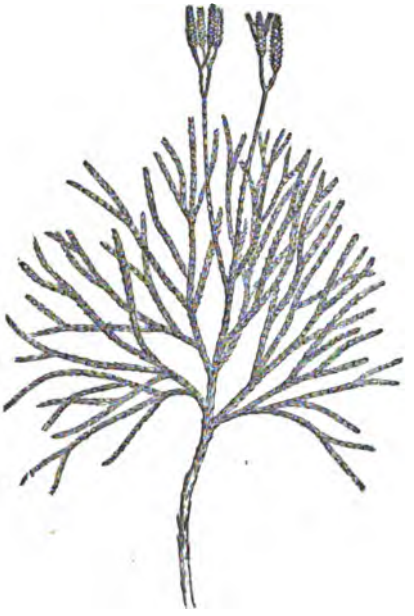
Fig. 424. The same seen from the outside.

Magnified 20 diameters.

leaves (figs. 423, 426, & 427), on the upper face or imbedded in it; and these fertile

leaves are either scattered all along the stem, or collected into spikes resembling, on a small scale, elongated Pine-cones (figs. 425, 435). The plants of the genus *Lycopodium* proper, exhibit both these conditions; but

Fig. 425.



Lycopodium complanatum.
One third the natural size.

Fig. 426. Fig. 427.

Selaginella apoda.

Fig. 426. Scale with oosporange. Magn. 20 diams.
Fig. 427. Scale with pollen-sporange. Magn. 20 diams.

in all these the spores are small and numerous and alike. In *Selaginella*, to which belong the elegant creeping Club-mosses, with flattened leafy stems (often with a metallic lustre), now so much grown in Wardian cases (fig. 428), the capsular leaves are in spikes, which are found forming one arm of a bifurcation of the stem, while the other continues the vegetative growth; and in the spikes we find the capsules on the lowest scales (*oosporanges*) producing only four spores (macrospores, figs. 426, 429), of much larger size than those (microspores) contained in large number in the other spore-cases (*pollen-sporanges*, figs. 427, 430). In *Lycopodium* and *Selaginella* the sporanges have but one cavity; in *Tmesipteris* the sporanges are two-celled, and in *Psilotum* three-celled. In *Isoëtes* (fig. 376, p. 443), where all the leaves are seated on a tuberous stem, and most of them fertile, the sporanges containing spores of each kind are many-celled, and immersed in the substance of the bases of the leaves.

Fig. 428.

Selaginella cernua. Half natural size.

Fig. 429. Fig. 430.

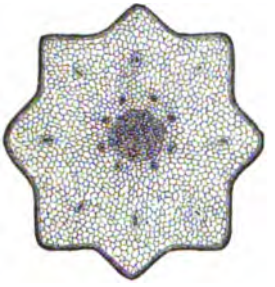
Selaginella cernua. Half natural size.

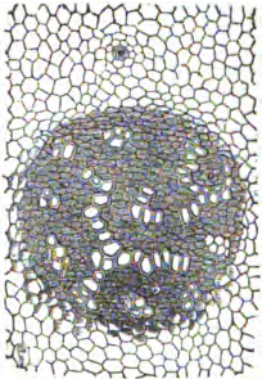
Fig. 429. Oosporange with four large spores. Magn. 20 diams.

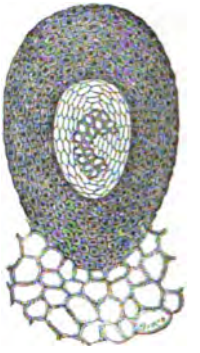
Fig. 430. Pollen-sporange burst, containing small spores. Magn. 20 diams.

The anatomical structure of the stem of the Lycopodieæ is not very complex. There is an outer thickish rind, composed of cellular tissue; and on cutting across a stem, the ends of isolated fibro-vascular bundles are sometimes seen traversing this; these isolated bundles are merely a portion of those forming a kind of cord running up the centre of the stem, whence they have been seen sent off to supply the leaves. The fibro-vascular bundles are composed of spiral-fibrous ducts surrounded by elongated

Fig. 431. Fig. 432. Fig. 433.







Lycopodium phlegmarium.

Fig. 431. Section of the stem. Magnified 20 diameters.
Fig. 432. The centre of ditto. Magnified 100 diameters.
Fig. 433. One of the isolated bundles of ditto. Magnified 200 diameters.

Fig. 434. Fig. 435. Fig. 436.

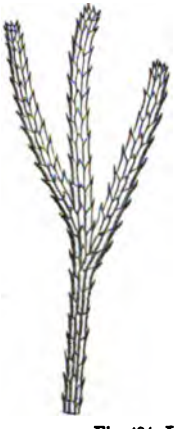


Fig. 434. Lycopodium complanatum. Young shoot.
Fig. 435. Lycopodium lucidulum. Spike of fruit. Magnified 3 diameters.
Fig. 436 Selaginella apoda. Young shoot. Magnified 2 diams.

cellular tissue (see TISSUES, VEGETABLE), which in large woody stems become lignified by secondary deposits. The roots have also a central fibro-vascular cord, connected with the central cord of the stem. The structure of the little-developed tuberous stem of *Isoëtes* is very different, and exhibits a remarkable mode of growth, forming annual layers of woody structure (see ISOËTES).

The leaves are of very simple structure; but their arrangement exhibits many curious peculiarities. In PSILOTUM, one of the simplest forms, where they are mere minute scales on a widely bifurcated stem, they are alternate; in some *Lycopodia* they are opposite, in others whorled. When the leaves are in whorls, they vary in number, not only in different species, but often in the same species in different localities, or even in the same plant: thus, the arrangement is often different on the main stem and on the branches.

When the leaves are opposite, those forming the pairs sometimes differ both in dimensions and form; in *Lycopodium complanatum* (fig. 434), the pairs of opposite leaves cross alternately at right angles, so as to form four rows up the stem; in two (opposite) rows the leaves are alike and flattened laterally; of the other two rows, one consists of leaves like the two just described, but flattened against the stem; and the fourth row (opposite the third) of minute scale-like bodies. In other cases, as in *Selaginella apoda* (fig. 436), the corresponding leaves of the pairs are unequal, and are so arranged that the smaller lie in two contiguous vertical rows, on the front of the stem. In most of the Lycopodiaceæ the leaves are simple and almost sessile; but in *Tmesipteris* they have a blade developed into two lobes and borne on a long stalk; and in *Psilotum* the short scale-like leaf is also divided into two lobes and supported on a petiole. The leaves of *Isoëtes* are different (see ISOËTES).

The reproduction of the Lycopodiaceæ is not uniform. In *Lycopodium* the spores are alike, producing monœcious prothallia; while in *Selaginella* and *Isoëtes*, as above stated, two kinds of spore exist, viz. microspores and macrospores. It is found that when both kinds of spore are sown, the results of their germination are totally distinct. The former small dust-like spores burst their outer coat after a time; and the delicate inner membrane, which is protruded, likewise bursts subsequently and discharges extremely minute cells, in each of which is developed an actively moving spiral spermatozoid, like those of the FERNS. This breaks out and swims about rapidly in the water when seen beneath the microscope.

The large macrospore exhibits no external change for a period varying from a few weeks to a few months; but a section shows that a process of cell-formation has commenced in its interior, which results in the production of a kind of disk of cellular tissue in the upper part, beneath that portion of the outer spore-coat which exhibits the three converging ridges produced by the pressure of the four spores in the parent sac during their development. At this period the spore appears to have three coats—an outer, tough, coloured coat, a second coat lining this, and a third which lines the second over the great cavity of the spore, but at the upper part invests the inside of the newly-formed disk of cellular tissue, which thus lies between the second and third coats. This disk of tissue is a *prothallium*; and on its upper surface are developed a number of *archegonia* of very simple structure. A cell of the substance of the *prothallium*, taking on the function of an *embryo-sac*, develops a free cell (*embryo-cell*) in its interior; and the cells between this and the surface become modified and part, so as to leave an intercellular canal between the contiguous angles of four adjoining cells, leading down to the embryo-cell,—the four cells growing up from the surface so as to form a kind of perforated cellular papilla, something like that of the archegone of the Ferns. At a certain stage of this development, the outer coat of the spore bursts at the converging ridges, and the angular flaps resulting turn back and expose the prothallium on the upper surface. One (sometimes two, but as an irregularity) of the embryo-cells is then fertilized by the spiral spermatozoids produced by the microspores, if these exist at the right stage of the development in the vicinity. After this, the embryonal cell undergoes multiplication, first growing down as a cellular filament which breaks through into the great cavity of the spore. The lower end lying there then increases until it acquires the form of a cellular nodule, which breaks out above and exhibits on its free portion the first adventitious root and the first pair of leaves. The rootlet makes its way downwards into the soil; and the leaves are

gradually elevated on a thread-like stalk, and separate, displaying two terminal buds between them, whence the first bifurcation of the stem proceeds.

This mode of reproduction allies the family very closely to the double-spored Marsileaceæ, and separates them from the Ferns and Equisetaceæ, in which the prothallium is formed outside the spores, after the germination of the single and only kind of spore which these plants possess. And by recent authors, the Lycopodiaceæ are separated from the Selaginaceæ, on account of the isosporous fructification of the one, and the heterosporous fructification of the other.

The order Lycopodiaceæ is divided into two families, in accordance with the structure of the sporanges:

Families.

LYCOPODIEÆ. Sporanges simple, one-celled.

PSILOTREÆ. Sporanges compound, many-celled.

BIBL. Hofmeister, *Vergl. Unters.* 1851, 111; De Bary, *Ann. Sc. Nat.* 4 sér. ix. 30, *Ann. N. H.* 3 ser. iii. 189; Faukhauser, *Bot. Zeit.* 1873; Strasburger, *Bot. Zeit.* 1873; Sachs, *Bot.* 474. See also ISOËTES.

LYCOPODIE'Æ.—A family of Lycopodiaceous plants, distinguished by their simple one-celled sporanges. The existing kinds are all herbs, mostly creeping over the ground; but some of the fossil kinds, met with especially in the Coal-measures, were large trees, the Lepidodendra. Genera:

Lycopodium. Sporanges all of one kind, containing numerous small spores resembling pollen-grains.

Selaginella. Sporanges of two kinds, the greater part resembling those of *Lycopodium*; one, situated at the base of the spikes, larger, often four-lobed, and containing only four large spores.

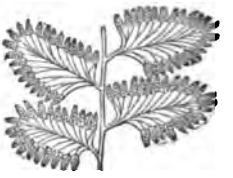
LYCOPO'DIUM, Linn.—A genus of Lycopodieæ. This has been sufficiently characterized under the head of Lycopodiaceæ. There are more than half-a-dozen British species, mostly alpine plants; but *L. inundatum* occurs on bogs in all parts of Britain.

BIBL. Hook, *Br. Fl.*; Babington, *Br. Bot.*; Francis, *Br. Ferns, &c.* See also LYCOPODIACEÆ.

LY'GEUM, Linn.—A genus of Graminaceæ; *L. spartum* is Esparto-grass.

LYGO'DIUM, Swartz.—A genus of Schizæaceæ (Polypodiaceous Ferns), consisting of beautiful climbing plants, with conjugate, palmate, lobed, or pinnate leaves, having the sessile sporanges in double rows on the teeth of the pinnules (fig. 437), each

Fig. 437.

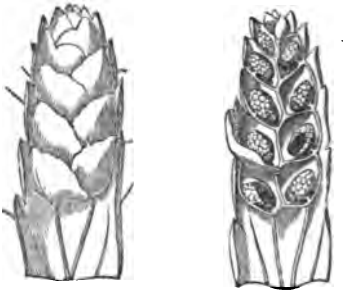


Lygodium reticulatum.
Portion of a leaf, with fertile pinnules. Nat. size.

having a hood-like special indusium (figs. 438, 439).

16 sp.; tropical. (Hook, *Syn.* 437.)

Fig. 438. Fig. 439.



Lygodium reticulatum.
Fig. 438. Tooth of a pinnule with overlapping indusia. Magn. 20 diams.
Fig. 439. The same, with the indusia removed to show the sporanges. Magn. 20 diams.

LYMPHATIC SYSTEM.—This consists of the lymphatic or absorbent vessels, and the lymphatic glands.

The lymphatic capillaries commence in the various tissues and organs, as fine networks or irregular lacunæ. The lacunæ are connected by canals and clefts, and form a lymph-canalicular system. The lymphatics of the intestines—the lacteals, commence as cæca.

In structure the lymphatics resemble the veins, but the walls are thinner in proportion to their calibre; they are also furnished with valves, formed by folds of the inner and epithelial coats.

The lymphatic capillaries are larger than the blood-capillaries. At the surface of the serous membranes, the lymphatics are con-

nected with small openings left between the epithelial cells, called STOMATA; so that the serous cavities and the lymphatic system are directly continuous. The lymphatics in their onward course unite, passing through the lymphatic glands, forming longer vessels, ultimately terminating by two trunks, one of which is the longest and called the thoracic duct, and which terminate in the angle formed by the internal jugular and subclavian veins on each side.

The lymphatic or conglobate glands consist of a capsule, composed of connective tissue with scattered fine elastic fibres, and in animals unstriated muscular fibres. The substance of the glands consists of a cortical and a medullary portion.

The cortical portion, which in the larger glands forms a layer about 1-6 to 1-4″ in thickness, exhibits a coarsely granular appearance, visible externally through the capsule. This arises from the presence of a large number of septa or trabeculæ prolonged from the capsule into the substance of the organ, and dividing it into alveoli; these are about 1-96 to 1-36″ in diameter, and of a rounded or polygonal form; they are more distinct in animals than in man. The septa consist of connective tissue with a few fine elastic fibres, and numerous delicate spindle-shaped bodies, often anastomosing at their ends.

The contents of the alveoli are greyish white, pulpy, traversed by capillary blood-vessels, and by numerous delicate fibres, with spindle-shaped and stellate cells resembling those found in the septa, but forming a lacunar or spongy adenoid tissue. The soft substance consists of free nuclei and rounded cells, resembling those found in the chyle and lymph.

In the medullary portion, the retiform tissue is very fine, closely filled with lymph-corpuscles, and connected with a plexus of lymphatics, ending in the efferent vessels.

The afferent vessels penetrate the capsule, pass through the septa between the alveoli, and open into their lacunæ, which are not lined with epithelium. From these, the lymphatics of the medullary plexus arise, to terminate in the efferent vessels.

The course of the lymph is from the afferent vessels into the capsular network, thence into the cortical and the medullary sinuses; from these into the network of lymphatics of the hilus, and finally into the efferent lymphatic vessels.

The injection of the lymphatics is a very difficult matter. Partial injections may be obtained by injecting the prussian-blue liquid into an aperture made in the different tissues or organs. The structure of the glands is made out, in ordinary sections well washed to remove the lymph-corpuscles. See on these matters, Rutherford's little 'Practical Histology.'

The lymph, or liquid contained in the ordinary lymphatics agrees essentially with the chyle, except that the molecular base is absent; the white corpuscles forming the characteristic microscopic elements. These are described at p. 101.

Lymphatics in Amphibia.—The structure and arrangement of the larger lymphatics differ in the Amphibia. They do not form cylindrical tubes, but lacunæ, which occupy the interspaces between the different organs, the surface turned towards the interior of a cavity being covered with a single layer of tessellated epithelium. These cavities or sacs communicate with each other by means of microscopic openings. As there are no contractile tissues in the walls of the sacs special contractile organs acting rhythmically, or lymph-hearts, are superadded. A very visible one in the frog is close to the sacrum, and pumps the lymph into the sciatic vein; another propels it into the jugular. They are chiefly composed of transversely striated short muscular laminæ.

BIBL. Kölliker, *Mik. Anat.* ii.; Todd & Bowman, *Phys. An.* ii.; Lane, Todd's *Cycl.*; Teichmann, *D. Saugad.*, 1862; Brücke, *Sitz. Wien. Akad.* 1852–1855; His, *Zeits. wiss. Zool.* xi., xii., xiii.; Recklinghausen, *Stricker's Hist.* i.; E. Klein, *Lymph. Syst.*, 1873; Sappey, *An. & Phys. d. vaiss. lymph.*, 1875; Frey, *Hist.* 1876, *and the lit.*

LYNG'BYA, Ag.—A genus of Oscillatoriaceæ (Confervoid Algæ), related to *Calothrix* and *Oscillatoria*, distinguished from the former by its stratified habit, from the latter by the long flexile but not oscillating filaments. It contains both freshwater and marine species. *L. muralis* (Pl. 8. fig. 10) grows in damp places and in water. The specific characters are not satisfactory; but we have found what we take to be *L. stagnina*, Kütz. Tab. Phyc. i. pl. 87. fig. 5, and *L. concinnata*, Kütz. *l. c.* pl. 89. fig. 5, in fresh water. *L. speciosa*, *Carmichaelii*, and *ferruginea*, marine species, are figured in Engl. Bot. Supp. Nos. 2926–27 *a* and *b*.

These plants appear to break up into lenticular gonidia; but their reproduction, like that of *Oscillatoria*, is very obscure.

Braxton Hicks has stated that *L. muralis*, a *Schizogonium*, and a *Prasiola* are all different stages of the same organism, and has noticed the segmentation of their gonidia into Palmelloid cells.

BIBL. Hassall, *Brit. Fr. Alg.* p. 219, pls. 59, 60, 72; Harvey, *Brit. Mar. Alg.* p. 225, pl. 26 E.; Kütz. *Spec. Alg.* p. 279; *Tab. Phyc.* i. pl. 86–90; Rabenh. *Fl. Eur. Alg.* ii. 135; B. Hicks, *Qu. Mic. Jn.* 1861.

LYSIGO'NIUM. See MELOSIRA.

M.

MACERATION.—The soaking of objects in various menstrua, for the purpose of causing decomposition and solution of portions of structure which are more readily attacked, is an operation frequently had recourse to in the anatomy both of animals and plants. In addition to water, cold and hot, a number of stronger agents are often employed, chiefly oxidizing substances, such as NITRIC ACID, the same combined with chlorate of potash, &c. Ammonio-oxide of copper dissolves delicate cellulose rapidly, and does not so soon attack woody fibre, &c. See TISSUES.

MACHI'LIS, Latr. See PETROBIUS.

MACROBIO'TUS, Schultze.—A genus of Tardigrada (Arachnida), family Arctisca.

Char. Head not furnished with appendages; mouth terminated by a sucker, without palps; skin soft, with irregular rugæ.

M. Hufelandii (Pl. 50. fig. 8). Body cylindrical, colourless; head rounded in front, with minute coloured eye-spots; sucker, pharyngeal tube, and styles well developed; œsophageal bulb supported by a solid frame-work of jointed pieces; legs equal; claws two, bifid, the point of each again bifid; movement tolerably quick; size 1-85 to 1-35″.

The most common species; found upon mosses growing on walls, stones, at the foot of trees, &c.

M. Oberhäuseri. Dark brown; colour distributed unsymmetrically in spots, and forming five longitudinal bands; no eye-spots; claws three,—one simple, terminal, and forming a short filament; the two others hooked, the interior one double or bifid, the posterior simple; movement very active; length 1-100 to 1-85″.

M. ursellus. Claws three, none filamentous.

M. Dujardinii. Claws two, bifid.

BIBL. Doyère, *Ann. Sc. Nat.* 2 sér. xiv., xvii. and xviii.; Dujardin, *ibid.* x.

MACROCY'PRIS, Brady.—An Ostracode, allied to *Bairdia*, among the *Cypridæ*, with long, smooth, pointed valves, and characterized by short setæ on the upper antennæ and rudimentary postabdominal rami. Living in the North Sea (*M. minna*, Baird); fossil in the Chalk (*M. siliqua*, Jones).

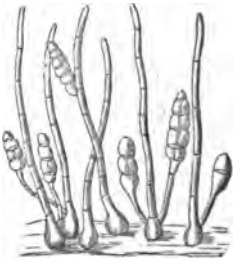
BIBL. G. S. Brady, *Linn. Tr.* xxvi. 391.

MACROGONIDIA.—A name applied to the larger form of ciliated zoospore found in many Confervoid Algæ, associated with a form much smaller, distinguished as MICROGONIDIA. See ZOOSPORES and HYDRODICTYON.

MACROSPORES, or MEGASPORES. See SPORES.

MAC'ROSPO'RIUM, Fr.—A supposed genus of Dematiei (Hyphomycetous Fungi), growing upon decaying vegetable matters, corresponding to *Septosporium*, Corda, and *Helmisporium*, Duby. Several species are British. *M. Cheiranthi*, Fr., is common on wallflowers and stocks; *M. Brassicæ*, Berk., on cabbage-leaves; *M. sarcinula*, on gourds; and *M. concinnum*, on rotting decorticated willow twigs. We have found one species among the OIDIUM of the vine-fungus.

Fig. 440.



Macrosporium bulbotrichum.
Magnified 200 diams.

Tulasne shows that they are conidiiferous forms of a Sphæriaceous genus. The spores of different species of *Macrosporium* were a very prominent feature in the organisms observed in deposits from the air at Calcutta.

BIBL. Berk. *Br. Fl.* ii. pt. 2. 339; *Ann. N. H.* i. 261, pl. 8. fig. 10, vi. 435, pl. 12. fig. 21; Fries, *Summa Veget.* 501; *Syst. Mycol.* iii. 274; Corda, *Ic. Fung.* i. 175, 176, 188; Tulasne, *Ann. Sc. Nat.* 4 sér.

v. 109; Cunningham, *Mic. Exam. of Air, Calcutta*, 1873.

MAC'ROTHRIX, Baird.—A genus of Entomostraca, of the order Cladocera and family Daphniadæ.

Char. Five pairs of legs; beak directed forwards; superior antennæ of considerable size, one-jointed, and pendulous from the beak; inferior antennæ two-branched, posterior branch four-, anterior three-jointed, and with a very long filament arising from the end of the first joint; a black spot at the root of the superior antennæ.

M. laticornis (Pl. 19. fig. 25). Shell oval, smooth, anterior margin strongly ciliated; eye areolar.

Found in ponds.

M. roseus. Eye without an areola; superior antennæ longer and more slender than in the above.

Probably a variety of the last. Found in Scotland.

Bibl. Baird, *Br. Entom.* 103; Norman & Brady, *Mon., Nat. Hist. Tr. Northumb.*

MADOTHE'CA, Dumortier (*Jungermannia*, L.).—A genus of Jungermannieæ (Hepaticæ), containing two British species:—one, *M. platyphylla* (fig. 441), common on walls, rocks, and trees; the other, *M. lævigata*, found on alpine rocks. The sporange is borne on a short stalk, globose, and bursts by four convex valves, from which the elaters are quite free. The globose persistent epigone is seen in the figure inside the two-lipped perigone.

Fig. 441.

Madotheca platyphylla. Magn. 5 diams.

Bibl. Endl. *Gen. Plant. Suppl.* i. 1341; Hooker, *Br. Fl.* ii. 125, *Brit. Jungermann.* pls. 35, 40, and Supp. pl. 3; Ekart, *Synops. Jungerm.* 52, pl. 3. fig. 24, pl. 6. fig. 44.

MAGNESIA, Salts of.

Ammonio-phosphate of magnesia or triple phosphate. This salt is frequently met with in animal secretions which have undergone decomposition, also in calculi. The most common forms are prismatic, and figured in the group *a*, *b*, Pl. 13. fig. 1; but their varieties are endless. Those of the above group are frequent in decomposing urine, blood, fæces, &c. Those in group *c* are occasional in urine. Those of group *d* are found in the contents of the vesiculæ seminales. The forms *e* and *f* are rare. Fig. 2 *a*, *b*, represents the so-called penniform crystals, or rather groups of crystals (prisms) occasionally found in urine. Fig. 3 represents the stellate form, occasionally found in urine; sometimes the minute and imperfectly formed crystals of fig. 4 are met with in the same liquid.

The crystals belong to the rhombic system. The prismatic crystals were formerly regarded as consisting of a neutral, and the feathery of a bibasic salt; but the composition of the two is the same, and the variation in form depends upon the conditions under which they are produced.

The prismatic forms may be prepared by allowing urine to decompose spontaneously, or by diluting this secretion with water and gradually stirring-in very dilute solution of ammonia in small quantities at a time; the penniform crystals by adding excess of solution of ammonia to very dilute solutions of the phosphate of ammonia and sulphate of magnesia; and the feathery forms by adding excess of ammonia to urine. The prismatic crystals form a beautiful polarizing object.

Sulphate of magnesia (Epsom salt). When crystallized upon a slide from an aqueous solution, the prisms of this salt, mounted in balsam, form an interesting polarizing object; they are also analytic.

Borate of magnesia fused into a bead before the blowpipe is a beautiful object (Sorby).

Urate of magnesia. See Uric Acid.

Bibl. That of Chemistry, and *Phil. Mag.* 1852, iii. 373.

MAG'NETITE. See Rocks.

MAGNIFYING POWER. See Measurement.

MAGOSPHÆRA, Haeckel.—A genus of Catallacta (Protista); according to Kent, a Flagellate Infusorian.

Bibl. Haeckel, *Jenai. Zeit.* 1870; Kent, *Inf.* 323.

MAHOGANY.—The wood of various species of *Swietenia* (Nat. Ord. Cedrelaceæ). Cross sections of this well-known wood form good objects for showing the structure of Wood with low power.

MAIZE.—Indian corn, *Zea Mays*, L.—One of the family of Grasses producing seeds used as corn. The seeds, or rather caryopses, are remarkably firm, being of a horny texture in the outer part of the substance, while the central mass is more or less brittle and soft. The solidity of the

grain results from the outer cells of the albumen being densely filled with starch-grains (Pl. 46. fig. 3), which, by pressure, assume a parenchymatous form and cohere together firmly. In the centre they are loosely packed in the cells, and then are of rounded forms (figs. 5 & 6). Figs. 1 to 4 represent successive stages of development of the starch-grains in the protoplasmic mass originally filling the cells, but finally almost wholly displaced. See STARCH.

MALLO'MONAS, Perty.—A genus of Cilio-flagellate Infusoria.

Char. Body oval, elliptic or discoid, with brown or greenish contents; surface covered with long non-vibratile hairs; a single long anterior flagellum.

2 species; marsh-water.

BIBL. Perty, *Inf.* 170; Kent, *Inf.* 464.

MALPIGHIAN BODIES. See KIDNEY.

MANDIOC or MANIHOT. See CASSAVA.

MANILLA HEMP.—One of the most delicate of vegetable fibres used for textile fabrics, yielded by the liber of the fibro-vascular bundles of *Musa textilis*, a kind of banana common in the Philippine Islands (Pl. 28. fig. 7). It is manufactured into "Manilla handkerchiefs" and "Manilla scarfs," consisting of a delicate muslin. These are often erroneously stated to be made of the fibre of some kind of Pine-apple. See TEXTILE SUBSTANCES.

BIBL. *Hooker's Journ. Bot.* 1849, i. 28.

MARANTACEÆ.—A family of Monocotyledonous Flowering plants, to which belong the true West-Indian arrow-root plants (see ARROW-ROOT), and the Tous-les-mois plants, species of CANNA. These substances consist of the starch (Pl. 46. figs. 18, 25, & 26) obtained from the tuberous rhizomes of the plants (see STARCH).

MARATTIA, Swartz.—The typical genus of Marattiaceous Ferns. Tropical (figs. 442 & 443). Hook, *Syn.* 440.

Fig. 442.

Fig. 443.

Marattia.

Fig. 442. Side view of a sorus.
Fig. 443. Indusium with the sorus removed.
Magnified 12 diams.

MARATTIA'CEÆ.—An order of Ferns, approaching the Polypodiaceæ in general habit, but more resembling the Ophioglossaceæ in their sporanges, which are destitute of an annulus, and often so fused together as to form a multilocular sac. Gen.:

Angiopteris. Caps. very close together, opening by a lateral slit.

Marattia. Capsules concrete, opening by internal slits.

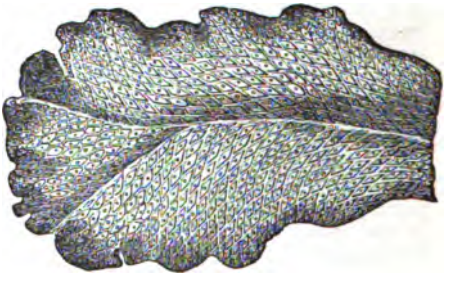
Danæa. Caps. concrete, opening by apical pores.

Kaulfussia. Caps. concrete, in raised circular masses, openings internal.

MARBLE. See ROCKS.

MARCHAN'TIA, Micheli.—A genus of Marchantieæ (Hepaticæ), Liverworts. The most common species is *M. polymorpha.* It is a little plant, not uncommon upon the earth of damp shady courtyards, the borders of springs, &c., extending itself in bright-green thin lamellæ of irregular lobed outline, attached to the soil by radical hairs arising on the lower surface. The frond presents an upper and lower epidermis, with an intermediate parenchyma; and the lobes are traversed by a kind of midrib. The upper surface is marked by raised lines which cross each other very regularly, leaving between them lozenge-shaped spaces (fig. 444), in the centre of each of which

Fig. 444.



Marchantia polymorpha.
Lobe of a frond.
Magnified 10 diameters.

occurs a stoma, leading to an intercellular space in the parenchyma. The stomata of *Marchantia* are circular, and consist of sixteen cells, arranged so as to form four rings, one upon another, each ring being composed of four cells; they may be best explained by comparing them with a chimney composed of four courses of bricks, each consisting of four bricks laid together to enclose a square. The parenchyma is composed of

several layers of cells, which contain much chlorophyll. The inferior epidermis is clothed with radical hairs, which exhibit a remarkable spiral marking, arising from the projection of a spirally deposited secondary layer in the interior of the tube.

The fronds do not readily develop sporanges in shady places; but when exposed to the light, they are produced at the ends of the ribs, at the base of the terminal notches

Fig. 445.

Marchantia polymorpha.
Plant with antheridial receptacles (male).
Nat. size.

of the lobes. The male structures are produced on different plants from the female; but both are borne on peculiar stalked receptacles. The first appearance of one of these receptacles is as a little green papilla surrounded by reddish scales, at the end of one of the principal ribs. As it enlarges, it pushes its way through the scales; and the rib on which it is borne elongates to form a pedicel, on which it is raised up perpendicularly above the surface of the frond,

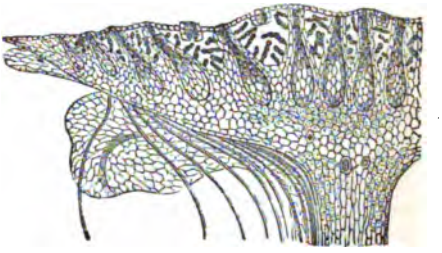
Fig. 446.

Marchantia polymorpha.
Plant with fertile receptacles (female).
Nat. size.

ultimately acquiring the form of an expanded cap. In the male receptacles it has a sinuate margin (fig. 445); and in the female the border is developed into eight or nine thick cylindrical lobes (fig. 446).

The male receptacle is concave above, with papillæ consisting of the mouths of flask-shaped cavities, in each of which is formed an *antheridium* (fig. 447). These

Fig. 447.



Marchantia polymorpha.
Section through an antheridial receptacle, showing flask-shaped cavities containing the antheridia.
Magnified 25 diameters.

antheridia are oval cellular bodies lodged in the expansion of the cavity, with a long neck projecting upward through the mouth of the flask-shaped excavation. The cells of the interior of the lower part of the antheridia produce spermatozoids (Pl. 40. fig. 32). The lower surface of the receptacle is clothed with membranous processes and hairs.

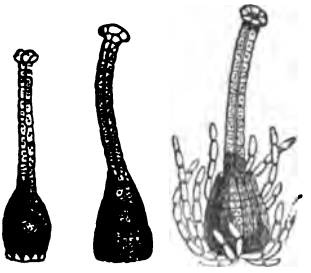
The female receptacles are somewhat

Fig. 448.

Marchantia polymorpha.
A sporangial receptacle seen from below.
Magnified 5 diameters.

convex above; and on the under surface of the base of each lobe are found delicate membranous processes with toothed margins. The membranes of each two adjoining lobes form a *perichætium* (fig. 448) alternating with the lobes, concealing between them the *archegonia*, which are attached by their bases, and have their mouths pointing downwards. The archegones of

Fig. 448*.



Marchantia polymorpha.
Archegonia in various stages.
Magnified 100 diameters.

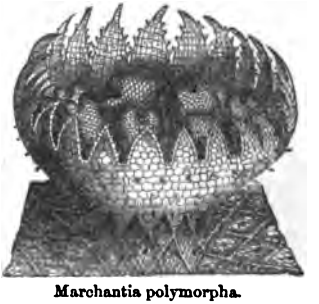
Marchantia are flask-shaped sacs with a long slender neck (fig. 448*), containing in their cavity a cell (germ-cell), which after fertilization becomes developed into an oval cellular body, the young *sporangium*. In the course of the development of this, it soon fills the cavity of the archegone, which then begins to grow with it, and subsequently forms a loose sac around it—the *epigonium*—finally ruptured at the point, so as to exhibit four or five teeth or valves, which become recurved (fig. 449). Meanring surrounding it (fig. 448*), but ultimately rising up so as to enclose it, remaining open however at the summit; this is the *perigonium*. In its young stages the sporange is a mere oval mass of polygonal cells; but a distinction may soon be detected between a cortical or peripheral layer and the internal mass. The cells of the former remain firmly united into a membrane forming the wall of the sporange. These cells grow so as to assume an elongated form, and when mature exhibit internally a spiral-fibrous secondary deposit (Pl. 40. fig. 35), analogous to that of the cells of the anthers of Flowering plants. The cells of the internal mass present at an early period the appearance of a large number of filaments radiating from the centre of the sporange to the wall. These soon become free from each other; and it may then be perceived that some are of very slender diameter, and others three or four times as thick. The slender ones are developed at once into the long *elaters* (Pl. 40. fig. 36) characteristic of this genus, containing a double spiral fibre, the two fibres, however, coalescing into one at the ends (fig. 37). The thicker filaments become subdivided by cross partitions, and break up into squarish free cells, which are the parent cells of the *spores*, four of which are produced in each (Pl. 47. figs. 10–13). The spores of *M. polymorpha* have but a single coat; and their contents are bright yellow when mature. When they germinate, the contents are converted into chlorophyll; and the growth commences by the production of a tubular process from one side of the spore.

Fig. 449.

Marchantia polymorpha.
Vertical section of Fig. 448, showing sporanges *in situ*, bursting to discharge the spores and elaters.
Magnified 10 diameters.

while another envelope grows up around the epigone, appearing at first as a mere

Fig. 450.



Marchantia polymorpha.
A collection of gemmæ in their involucre.
Magnified 25 diameters.

It has been mentioned that *M. polymorpha* does not fruit freely in the shade. Under

these circumstances it produces *gemmæ*, consisting of little, compressed, oblong masses of cells, of green colour, capable of reproducing the plant. These are found, when mature, in elegant cup-like structures, with toothed borders, sessile on the upper face of the frond (figs. 446, 450). The cup seems to be formed by a development of the superior epidermis, which is raised up and finally bursts and spreads out, laying bare the gemmæ, produced from the internal parenchyma. The gemmæ consist at first of a single cell, which divides so as to present an upper and a lower (stalk-) cell; the upper multiplies until it becomes a cellular mass (fig. 451). The

Fig. 451.

Marchantia polymorpha.
A vertical section of the same, with nascent gemmæ.
Magnified 50 diameters.

development of this structure presents much analogy to that of the sori of the Ferns with their indusia and sporanges.

The *Marchantiæ* also increase by *innovations*, or lobes of the frond becoming detached from those on which they originate.

These plants form most interesting objects of microscopic investigation, in all parts of their structure.

Bibl. Hook. *Br. Fl.* ii. pt. 1. 105; *Engl. Bot.* pl. 110; Mirbel, *Mém. Acad. Paris*, xiii. 337, 375; Nägeli, *Linnæa*, xvi. 1842; Henfrey, *Dev. of Spores &c., Linn. Tr.* xx. 103, pl. 11; Thuret, *Anthéridies, Ann. Sc. Nat.* 3 sér. xvi. 72, pl. 12; Gottsche, *Bot. Zeit.* 1858, *Suppl.*; Strassburger, *Jahr. wiss. Bot.* vii. 409; Sachs, *Bot.* 354.

MARCHANTI'EÆ.—A family of Liverworts or Hepaticæ.—Brit. Genera: *Marchantia, Fegatella, Reboulia, Lunularia.* See Hepaticæ.

MARGARIC ACID and MARGARINE.—The former general ingredient of the fatty matters of both the animal and vegetable kingdom, when crystallized from hot alcohol, forms minute needles, either isolated or in groups (Pl. 11. fig. 16 *a*). The crystals differ from those of stearic acid, which form lanceolate single or aggregated plates (Pl. 11. fig. 16).

Margarine crystallizes from a hot alcoholic solution in fine needles, mostly grouped or branched, sometimes surrounding globules of oleine, or forming bulb-like aggregations of needles (Pl. 11. fig. 15). It is sometimes found crystallized within the cells of fatty tissue (Pl. 11. fig. 15 *a*).

Margaric acid is now regarded as a mixture of palmitic and stearic acids, and margarine as a combination of these acids with glycerine.

Bibl. That of Chemistry.

MARGINULI'NA, D'Orb.—A Nodosarine Foraminifer, elongate, equilateral, curved or spiral in its earlier portion; chambers globular or compressed; orifice rounded, marginal. *Nodosaria raphanus* becomes Marginuline with an eccentric aperture (Pl. 23. figs. 30–32); and, by gradual modifications, *Marginulina* passes into *Cristellaria*, with which Williamson unites it.

Common in existing seas; and fossil from the Trias upwards.

Bibl. Williamson, *Rec. Foram.* 30; Morris, *Br. Foss.* 37; Parker & Jones, *Ann. N. H.* 3. xii. 432; Carpenter, *Intr. For.* 163.

MARSIL'EA, L.—A genus of Marsileaceæ (Flowerless Plants), growing in mud, by a creeping rhizome, from which arise erect filiform leaf-stalks, supporting a compound four-lobed blade; at the bases of the leaf-stalks arise also stalked capsules, chambered in the interior, being divided by one perpendicular and many horizontal septa; in these chambers are found sacs (sporanges) containing the spores. This plant agrees in all essential respects with Pilularia. See Marsileaceæ.

MARSILEA'CEÆ.—A family of Flowerless plants possessing a slight leafy stem; composed of a small number of plants, of minute dimensions, but of great interest in a physiological point of view. They are all aquatics, some growing in the mud in and around ponds, others floating on the surface of stagnant waters. They all bear distinct spore-fruits or sporocarps, seated on a stalk arising from the stem. These contain sporanges or spore-sacs, differently arranged in the different genera, but agreeing in this respect, that they contain spores of two kinds, macrospores and microsporus, analo-

gous to the two kinds of spore in Lycopodiaceæ, but differing in their mode of development.

Pilularia globulifera is the only British representative of this family.

Bibl. Hofmeister, *Vergl. Unters.* 103, pls. 21 & 22; Henfrey, *Tr. Br. Assoc.* 1851; *Ann. N. H.* 2 ser. ix. 447; Hanstein, *Monatsb. Ak. Berlin*, 1864, *Ann. N. H.* 1864; Sachs, *Bot.* 444 (fig.).

MARSIPEL'LA, Norm.—A delicate arenaceous Foraminifer, related to *Astrorhiza*. (Norman, *Ann. N. H.* 5. i. 281; Brady, *Qu. Mic. Jn.* xix. 17.)

MARY'NA, Grüber.—A genus of Holotrichous Infusoria. Bodies cup-shaped, with a funnel-shaped cleft neck; terminal on the ends of a branched zoary. *M. socialis*, marine (Kent, *Inf.* 520.).

MASTIGAMŒ'BA, Schulze.—A genus of Flagellate Infusoria.

Char. Amœba-like, changeable, creeping, emitting pseudopodia, with an anterior flagellum. Four species; freshwater. *M. aspera* (Pl. 53. fig. 22). (Kent, *Inf.* 221.)

MASTIGOB'RYUM. See Herpetium.

MASTIGOCER'CA, Ehr.—A genus of Rotatoria, of the family Euchlanidota.

Char. Eye single and cervical; tail-like foot styliform; carapace prismatic, with a dorsal crest.

M. carinata (Pl. 43. fig. 46, side view). Foot as long as the body; freshwater; entire length 1-72″.

Bibl. Ehrenberg, *Infus.* p. 460.

MASTIGOC'LADUS, Cohn.—A genus of Confervoid Algæ, allied to *Sirosiphon*.

Char. Filaments moniliform, dichotomously ramose, without sheaths. Secondary branches with cylindrical cells, among which are some elliptical; forms a fleshy, spongy layer.

M. laminosus (Pl. 52. fig. 9), in warm springs.

Bibl. Rabenh. *Fl. Eur. Alg.* ii. 284.

MASTIGONE'MA, Schwabe.—A genus of Rivulariaceæ.

Char. Filaments tufted, articulated, elongate, with thin ends, sheathed; apex of the sheath open. *M. plana*, an Irish and Scottish species.

Bibl. Rabenh. *Fl. Eur. Alg.* ii. 226.

MASTIGOPH'ORA, Hincks,=*Lepralia* pt. (Hincks, *Polyz.* 278).

MASTIGO'THRIX, Kütz.—A genus of Rivulariaceæ.

Char. Filament single, bent, flagelliform, ending in a produced hyaline process, sheathed and jointed; on freshwater Algæ.

M. æruginosa (Pl. 52. fig. 10).

Bibl. Rabenhorst, *Alg.* ii. 225; Kütz. *Phyc. Gener.* 232.

MASTOGLO'IA, Thwaites.—A genus of Diatomaceæ.

Distinguished by the *Navicula*-like frustules, the hoops of which are furnished with loculi, immersed in a mammillate frond.

Five British species, marine and freshwater.

M. lanceolata (Pl. 51. fig. 26). Valves lanceolate, elliptical, ends acute; loculi 8–30; in brackish water.

M. Danseii = *Dickieia Danseii*, Thw.

Bibl. Smith, *Brit. Diat.* ii. 63; Thwaites, *Ann. N. H.* 1848, i. 171.

MASTOGO'NIA, Ehr.—A doubtful genus of fossil Diatomaceæ.

Char. Frustules single; valves dissimilar, angular, mammiform, orbicular at the base, free from umbilical processes, not cellular, angles radiating.

The (eight) species are interesting from the structure of the two valves of the frustules differing. Thus in one, *M. Crux* (Pl. 18. fig. 23 *a*) the angles and rays are four in one valve, but seven in the other; in

Fig. 452.

Fig. 453.

Fig. 454.

Matonia pectinata.

Fig. 452. Part of a fertile pinna. Magn. 3 diams.

Fig. 453. Indusium opened at the side, showing theca *in situ*. Magn. 25 diams.

Fig. 454. The same with the thecæ removed. Magn. 25 diams.

M. actinoptychus (Pl. 18. fig. 23 *b*) the angles and rays are nine in one valve, and thirteen in the other, and so on. Diameter from 1-1600 to 1-800''.

M. hexagona (Pl. 18. fig. 25).

Bibl. Ehrenb. *Ber. Berl. Akad.* 1844; Kütz. *Sp. Alg.* 25.

MATO'NIA, R. Brown.—A genus of Cyatheæ (Polypodiaceous Ferns).

M. pectinata (figs. 452–454) Exotic. (Hook, *Syn.* 45.)

MAURAN'DYA.—A genus of Scrophulariaceæ (Dicotyledons), the testa of the seed of which is composed of cells with spiral-fibrous deposits, forming an elegant microscopic object.

MEASUREMENT and Measures.—In this article we shall consider the method of measuring the magnifying power of a microscope, of ascertaining the dimensions of objects, and shall give a sketch of the standard measures in which the dimensions of objects are expressed.

Measurement of the magnifying power of a microscope.—The apparent size which an object appears to possess under a microscope will vary according to the power of the object-glass and of the eye-piece used, and the length of the body of the microscope; and it is a good plan to determine the measurements once for all in the case of the various object-glasses and eye-pieces, keeping them written upon a card, so that they may be readily accessible.

The apparatus requisite consists of a glass micrometer-slide graduated into thousandths of an inch, each tenth division being marked by a longer line; or two separate slides, one graduated into thousandths, the other into hundredths of an inch; and an ivory scale, graduated into inches, tenths, and hundredths.

The simplest method is that by double sight, as it is called. The micrometer-slide is placed upon the stage, the lines brought into focus, and the image of one of the interspaces, as seen upon the stage with the open eye not used in looking through the microscope, is measured with compasses. By then dividing the measure of the image of the space by the known measure of the unmagnified space, the quotient is the required magnifying power. Thus, if the space on the micrometer-scale is equal to the 1-100th of an inch, and the image of the magnified space corresponds to 5-10ths of an inch, the space is magnified 50 times: $\frac{5}{10} \div \frac{1}{100} = 50$.

The same result may be obtained with the aid of the camera lucida, by placing the microscope horizontally, and its axis at a distance from the table equal to the distance between the focus of the eyepiece and the stage; the breadth of the image of a division is then measured as before; and this is the best and most certain method.

A most important point in relation to this subject is that the joint of the microscope shall be furnished with a stop or pin (Introduction, p. xv), by which the body may be placed horizontally at once, so that all objects which are drawn under the same object-glass and eyepiece may be magnified to the same extent, the degree being determined by the second of the above methods.

The obvious use of being acquainted with the magnifying power of a microscope is that objects under examination may be viewed by the same power as that with which figures of them have been made, so that the structure or appearance of the objects in the two cases may be compared.

In the above estimation of the magnifying power, one dimension only is taken into account, viz. the breadth or diameter; and this is the ordinary manner in which the magnifying power is stated; objects are then said to be magnified so many diameters, or so many times linear.

Measurement of the size of objects.—This is effected with the aid of a slide micrometer passed through two slits in the eyepiece above the stop, and at the focus of the upper glass of the eyepiece. The breadth of the spaces between the lines must be such as to give an even and minute fraction of an inch. The value of the spaces will vary with the power of the object-glass and eyepiece; so that it must be determined in each case, and recorded. For measuring small objects, the breadth of the spaces in the eyepiece-micrometer may be such that twenty of them correspond to 1-1000th of an inch in the stage-micrometer slide, so that the value of each division will be the 1-20,000th part of an inch. It is seldom that we have to measure objects so small as this; but the small size is of great advantage, because in most cases it will happen that the margins of the objects will coincide exactly with some of the lines, whereby the chance of error in computation will be avoided. For larger objects, the spaces of the eyepiece-micrometer may be coarser.

The method of measuring scarcely requires

further explanation. Supposing, however, that the divisions of the stage-micrometer are equal to 1-1000th of an inch, and those of the eyepiece-micrometer equal to 1-20,000th of an inch (*i. e.* twenty of them cover one space in the former), an object brought into focus and covering five of the spaces of the eyepiece-micrometer, will be 1-4000th of an inch in diameter; and so for other dimensions. When the objects are large, the compasses and the ivory scale will suffice for their measurement; but sometimes this may be conveniently done under a low power, for the 1-100ths of an inch are not very clearly discernible to all eyes.

In measuring objects, they must be covered with thin glass, and not immersed in too much liquid.

It is a matter of great difficulty, under high powers, to adjust accurately the divisions of the eyepiece-micrometer to those of the stage-micrometer, or to the margins of objects, by means of the movable stage; a very ingenious apparatus has been contrived by Jackson to overcome the difficulty. It consists of a little brass frame, in which the eyepiece-micrometer slides from side to side, the motion being communicated by the end of a screw working against one end of the slide, and resisted at the other by a spring; and as the magnifying power with which the divisions of the eyepiece-micrometer are viewed is small, the adjustment is easily and accurately effected.

Hartnack's diagonal scale is very useful; and very minute investigations and measurements may be taken with it and with Jackson's eyepiece-micrometer to 1-100,000th of an inch.

Other micrometers, as the "cobweb-micrometer," are made; but as they are very expensive, we shall pass them over.

Some authors express the measurement of objects by means of a ruled scale appended to the figures or plates of them, the scale consisting of divisions of a stage-micrometer of known value traced off under the same power as the objects themselves; or sometimes the divisions are ruled over the figures. These methods are very objectionable, because the size of the objects cannot be ascertained without measuring with compasses and calculation, which is almost as bad as the size being omitted altogether.

Whenever figures of objects are given, the magnifying power with which they are drawn should always be expressed in numbers near the figures.

Measures.—The measures in which the dimensions of objects are expressed should consist of parts of an English inch, and not of a line. On the continent, fractions of a millimetre, or of a Paris, or Prussian line are used. When fractions of a millimetre are adopted, this is usually denoted by the addition of ^{mm} to the figure or figures.

The following data will be found useful in reducing the foreign to the English measures:—

A millimetre = 0·0393707 English inch; or rather less than 1-25th of an English inch.

A centimetre = 0·393707 Eng. inch; or rather more than 1-3rd Eng. inch.

A Paris line = 0·088815 Eng. inch; or rather more than 1-11th Eng. inch, to which vulgar fraction it is nearest.

To convert a foreign into the English measure, the former must be multiplied by its unit-value; thus, 0·25^{mm} (millimetre) × 0·0393707 = 0·009842675 Engl. inch. But in most cases a few decimal places only need be observed. In this way, however, we get a rather long sum, which may be avoided by the use of the following Table.

Table for conversion of foreign into English measures.

	Millimetres into English inches.	Old Paris lines into English inches.	Prussian lines into English inches.
1	·039370	·088815	·085817
2	·078741	·177630	·171633
3	·118112	·266445	·25745
4	·157483	·355260	·343267
5	·196853	·444075	·429083
6	·236224	·532890	·51490
7	·275595	·621705	·600717
8	·314966	·710520	·686532
9	·354337	·799335	·77235

in which the numbers in the first (or left-hand) column correspond to the denominations expressed in the uppermost (head) line of the three broader columns, while the fractions opposite these numbers denote their values in parts of the denominations of the lowermost (head) line. Thus, 1^{mm} = 0·039370 Eng. inch; 3^{mm} = 0·118112; 2 Prussian lines = 0·171633 Eng. inch, and so on. In using this Table, the decimal

fraction to be converted into parts of an English inch must be broken up into its decimal parts, and each valued separately from the Table; thus, to convert 0·75^{mm} into a fraction of an English inch—

$$\left.\begin{array}{l} 0{\cdot}7^{mm} = 0{\cdot}0275595 \\ 0{\cdot}05^{mm} = 0{\cdot}00196853 \end{array}\right\} \text{(by the Table).}$$
$$0{\cdot}75^{mm} = 0{\cdot}02952803 \text{ Eng. inch.}$$

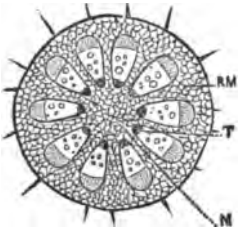
The only circumstance which requires attention in the use of this Table is the position of the decimal point. Thus, in the above measure of 0·75^{mm}, which, when broken up, makes 0·7^{mm} and 0·05^{mm}, if the first value (0·7) had been 7·0, the value in Eng. inch would have been, according to the Table, 0 275595 Eng. inch; but this is 10 times too much, or = 7 whole millimetres; hence the shifting of the decimal point, and so on. To express the mode of proceeding by rule,—the decimal point in the fraction of an English inch given by the Table should be shifted to the left, and as many ciphers added as there are decimal places in the foreign measure.

Harting introduced a new measure, the $\frac{1}{1000}$th of a millimetre = ·000039 in., called a micromillimetre, expressed by μ. This and its multiples are often used in foreign works. The μ is nearly equal to the $\frac{1}{25000}$ of an English inch. But we agree with Frey, that its use possesses no advantage.

Throughout this work the foot and inch and their fractional parts are expressed for brevity by placing respectively one or two acute accents on their right side; thus, one foot is denoted by 1′, one inch by 1″, and $\frac{1}{10}$th of an inch by 1·10″.

MEDUL'LA OF PLANTS.—The name formerly applied to the pith of Dicotyledons (fig. 455 M), from a supposed analogy with

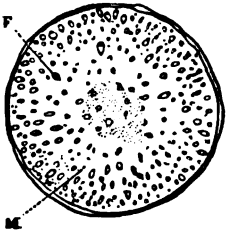
Fig. 455.



Horizontal section of a yearling shoot of a Dicotyledon. M, medulla; RM, medullary rays; T, medullary sheath. Magnified 25 diameters.

the *medulla spinalis* of animals. It affords excellent sections of regular parenchymatous tissues, as in the elder and in the tall annual stems of many of the larger perennial herbaceous plants. It sometimes becomes curiously chambered as it grows older, as in the walnut and the jasmine; very frequently, however, it decays after a time, leaving the centre of the stem hollow; this same hollow condition occurs early in fistular stems, such as those of the Umbelliferæ, from the pith being torn up by rapid expansion of the wood. The Monocotyledons do not generally possess a definite pith; the cellular mass, in which the isolated FIBRO-VASCULAR BUNDLES are imbedded, answers to a diffused pith, or rather to the pith and medullary rays collectively. It may be seen well in sections of the flowering stem of lilies (fig. 456 M).

Fig. 456.



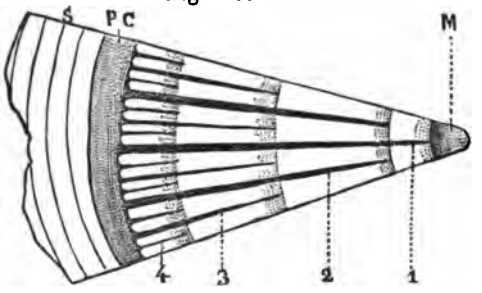
Horizontal section of the flowering stem of a lily. M, medulla; F, fibro-vascular bundles. Magnified 5 diameters.

A more definite medulla occurs in the stem and leaves of the rushes and sedges, where also the cells are often elegant radiating forms, leaving large air-canals between them (Pl. 47. fig. 18). The pith of a Dicotyledonous stem loses itself gradually in the terminal bud, where it is confounded with the nascent wood and cortical layers. In this stage its cells possess an active vitality, which, however, is soon lost.

MEDUL'LARY RAYS.—The processes of cellular tissue extending outwards from the pith, between the fibro-vascular bundles of a Dicotyledonous stem in the first year of growth (fig. 455 RM), together with additional interposed rays formed between the older in each succeeding annual layer of wood (fig. 457, 1, 2, 3, 4). The tissue of these rays generally becomes much compressed during growth; but their size and the degree of development differ much in

different cases. In radial sections of Dicotyledonous wood they often appear distinctly to the naked eye, from the direction of their cells being different from that of the woody fibre, and therefore reflecting light differently; this causes the "silver grain" as it is called of oak panels, &c.; in tangential sections of the trunk, the ends of the medullary rays usually appear as short, more or less regular, narrow streaks.

Fig. 457.



Section of a four years' old shoot of the Cork oak. M, pith; 1, 2, 3, 4, medullary rays of successive years; P. C, liber layers; S, cork layers.

Magnified 20 diameters.

MED'ULLARY SHEATH.—The earliest layer of fibro-vascular tissue developed in a Dicotyledonous stem, consists ordinarily of spiral vessels, these forming the foundation of the wood-bundles (fig. 455 T). As the latter stand in a circle round the pith, their internal vascular layers of course form collectively a continuous cylindrical envelope to the pith; this is called the medullary sheath. It is absent in some Dicotyledonous stems, for example in the Orobanchaceæ.

MEDU'SÆ. See ACALEPHÆ.

MEE'SIA, Hedw.—A genus of Bartramioid Mosses; one species, *M. uliginosa* (= *Bryum trichodes*), certainly British; another, *M. longiseta*, doubtful.

MEESIA'CEÆ.—A tribe of Bartramioid Mosses, containing two genera, of which there are but few British representatives. See MEESIA and PALUDELLA.

MEGALOT'ROCHA, Ehr.—A genus of Rotatoria, of the family Megalotrochæa.

Char. Eyes two, red, sometimes disappearing with age.

Rotatory organ two-lobed or horse-shoe-shaped; teeth in rows.

M. albo-flavicans, E. (Pl. 44. fig. 1). Colourless and unattached when young, yellowish and grouped in radiant clusters when old; freshwater; length of individuals 1-36″; of the clusters 1-6″.

The ova remain some time attached to the parent by a cord.

M. velata, Gosse.

BIBL. Ehr. *Infus.* 396; Gosse, *Ann. N. H.* 1851, viii. 198; Pritch. *Infus.*

MEGALOTROCHÆ'A, Ehr.—A family of Rotatoria.

Char. Neither envelope nor carapace present; rotatory organ simple, notched or sinuous at the margin.

Three genera:

Eyes none..... *Cyphonautes.*
Eyes present
Eye one..... *Microcodon.*
Eyes two ..... *Megalotrocha.*

BIBL. Ehr. *Infus.* p. 394.

MEGAM'ERUS, Dugès.—A genus of Trombidina (Acarina).

Char. Palpi long, free, with a claw; mandibles forcipate; body constricted; coxæ distant; legs ambulatory — femora, especially of the fourth pair, very large, seventh joint short.

Several species. They live in damp shady places, and move rapidly.

M. celer (Pl. 6. fig. 33: *a*, labium; *b*, palp). Minute; abdomen oblong; the sides narrowed posteriorly, covered with hairs, and with three terminal setæ; labium bifid; mandibles with a movable, elongated, pointed and curved claw.

Pl. 6. fig. 33 *c*, mandible of *M. roseus*.

BIBL. Dugès, *Ann. Sc. Nat.* 2 sér. ii. 50; Gervais, *Walck. Arachn.* iii. 169; Murray, *Ec. Ent.* 115.

MEGAP'ORA, Hincks, = *Lepralia* pt. (Hincks, *Polyz.* 171.)

MEGU'RA, Buckt.—A genus of Aphidæ. Black, eyes red; on *Vicia sepium*. (Buckton, *Aphid., Ray Soc.* i. 188.)

MELAMPSO'RA, Cast.—A genus of Uredinei (Coniomycetous Fungi), distinguished by producing two distinct kinds of spores—summer and winter spores. The species are very common on the willow, birch, poplar, &c., forming yellow or orange spots upon the leaves. (Cooke, *Handb.* 522; Tulasne, *Ann. Sc. N.* 4. ii. 94.)

MELANCONI'EI.—A provisional family of Stylosporous Fungi, distinguished from Sphæronemei by the perithecium being obsolete or altogether wanting. The spores, which vary much in the different genera, are ultimately protruded in the form of

tendrils or otherwise. They are all mere forms of Sphæriacei.

MELANCO'NIUM, Lk.—A supposed genus of Melanconiei (Stylosporous Fungi), so called from forming a kind of black rust on branches of trees, reeds, &c. Several species have been found in Britain. The commonest is *M. bicolor* (*Didymosporium elevatum*, Br. Fl.), on twigs of birch. Fries places also *Cryptosporium vulgare* here. These plants are forms of Sphæriacei. See CONIOMYCETES.

BIBL. Berk. *Brit. Flor.* ii. pt. 2. p. 357; *Ann. N. H.* vi. p. 438; Fries, *Summa Veg.* p. 508; Tulasne, *Ann. d. Sc. Nat.* 4. sér. v. p. 109.

MEL'ANINE.—The black or brown pigment met with in the choroid and uvea; in the *rete mucosum* of man, especially the negro, and animals; in hair, feathers, &c.; and in the blood in malaria. These pigments are derived from hæmatine and hæmoglobine, and exist usually in the form of very minute granules. They are insoluble in water, alcohol, ether, and acids; but are sometimes soluble in alkalies or solution of chlorine. The lungs and bronchial glands often contain a black pigment, which is unacted upon by these reagents, and is derived from carbonaceous matter admitted through the respiratory organs. (Rindfleisch, *Path. Hist.* 167; Hoppe-Seyler, *An. Chim.* 240.)

MELANOGAS'TER, Cd.—A genus of Hypogæous Gasteromycetous Fungi. Two species occur in this country, under beech, Lombardy poplars, &c. *M. variegatus* (fig. 54, p. 92) is sold in the market at Bath under the name of Red Truffle, but it has none of the fine flavour of the real Truffle. *M. ambiguus* is very fetid, smelling like assafœtida.

BIBL. Tul. *Fung. Hyp.* t. 2. f. 4, 5; Berk. *Outl.* 293; Cooke, *Handb.* 356.

MELANOTHE'CA, Fée.—A genus of Pyrenodei (Lichenaceous Lichens).

Char. Thallus scarcely any; apothecia verrucaroid, numerous, confluent; hymenia scarcely distinct; perithecium black; spores 8, variously divided. Two British species, on trees. (Leighton, *Lich. Flora*, 498.)

MELAS'MIA, Lév.—A supposed genus of Sphæronemei (Coniomycetous Fungi), but apparently only a stylosporous form of RHYTISMA. *M. acerina* occurs on the leaves of the sycamore, forming black spots, sometimes as much as 1-2″ in diameter.

BIBL. Berk. *Ann. N. H.* 2 ser. v. 456; Léveillé, *Ann. Sc. Nat.* 3 sér. v. 276; Fries, *Summa Veg.* 423.

MELASPI'LEA, Nyl.—A genus of Graphidei (Lichenaceous Lichens).

Char. Apothecia black, superficial, arthonoid; spores 1-septate; paraphyses distinct. Five species. (Leighton, *Lich. Flora*, 436.)

MELICER'TA, Schrank.—A genus of Rotatoria, of the family Floscularieæ.

Char. Bodies each in an isolated tubular carapace or urceolus; rotatory organ four-lobed; eyes two, at least when young.

M. ringens (Pl. 44. fig. 3; fig. 4, animal removed from the sheath; fig. 6, jaws). Carapace conical or cylindrical, brownish, composed of numerous rounded or discoidal bodies agglutinated together; body colourless. Length of carapace 1-36 to 1-24″.

Frequently found attached to water-plants, especially *Potamogeton crispus*.

BIBL. Ehr. *Infus.* 404; Williamson, *Micr. Jn.* 1852; Gosse, *Tr. Mic. Soc.* 1851, iii. 62; Bedwell, *Jn. Mic. Soc.* 1878, 176; *Ann. N. H.* 1881, viii. 448.

MELI'OLA, Fr.—A genus of Ascomycetous Fungi, belonging to the division Perisporiacei.

All the species are exotic, occurring on various leaves, and distinguished by their highly developed mycelium and large septate sporidia.

BIBL. Léveillé, *Ann. Sc. Nat.* 1846, v. 266; Mont. *Cuba Crypt.* 327.

MELOBE'SIA, Lam.—A genus of Corallinaceæ. Nine British species, on rocks and other Algæ (Harvey, *Mar. Algæ*, 107). The capsules (ceramidia) form little blunt cones, scattered over the crusts, and containing tufted tetraspores as in *Corallina*.

MELOLON'THA, Fabr. (Cock-chafer).—A genus of Coleopterous Insects, family Melolonthidæ.

The structure of *M. vulgaris*, the common cock-chafer, has been elaborately studied and described.

BIBL. Suckow, *Naturg. d. Maikäfers*; Straus-Dürckheim, *An. comp. d. Insect.*; Westwood, *Introd.*

MELOPH'ILA, Nitzsch (*Melophagus*, Latr.).—A genus of Dipterous Insects, family Hippoboscidæ.

Char. Head posteriorly received in an excavation of the thorax; wings and halteres absent; last joint of the tarsus largest.

M. ovinus, the sheep-tick (Pl. 35. fig. 23). Common upon sheep. Antennæ small, sunk in an eye-like cavity of the head; eyes small, oval, resembling two groups of ocelli; setæ

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MELOSIRA.

three, enclosed in two sheath-like, hairy, unjointed organs (labial palpi), resembling otherwise those of Pulex, and arising from the sides of a triangular labium. Legs robust: tarsi with two stout serrated claws, each having at its base a blunt process; across panying the claw is an elegant feathery tarsal brush; and on the under side of the last tarsal joint is a bilobed pectinate organ.

BIBL. Lyonnet, *Anat. et les métamor.*; Gurlt, *Magaz. f. d. gesam. Thier.* 1843, ix.; Westwood, *Introd.*; Curtis, *Br. Entom.* 142; Dufour, *Ann. Sc. Nat.* 1845, iii.; Leuckart, *Fortpflanz. der Pupiparen.*

MELOSI'RA, Ag. (*Gallionella*, Ehr.).—*Char.* A genus of Diatomaceæ. *Frustules* cylindrical, discoidal or subspherical, united into jointed filaments. Hoops often very broad, to adapt themselves to the breadth of the new frustules. In some species a narrow projecting ridge or keel encircles the valves near their ends. Valves covered with dots, which are mostly very minute and invisible under ordinary illumination; in the side view they sometimes have a radiate arrangement. In some species the margins of the ends of the frustules (side view) have coarse and distinct radiating striæ.

This genus has been subdivided by Ehrenberg and Kützing into:—*Lysigonium*, in which the keel is present; and *Gallionella* (proper), in which this is absent. Again, by Thwaites into:—*Aulacosira*, in which the frustules are cylindrical, surrounded transversely by two furrows, with rounded (convex) ends, but no line for division; *Orthosira*, in which the frustules are exactly cylindrical (with flat ends), exhibiting the transverse line of division, and with spherical or subspherical internal cavities; and *Melosira* (proper), in which the frustules are convex at the ends, and have the central line of division.

Numerous British species.

* *Marine.*

M. nummuloides, Kg. (Pl. 17. fig. 5 *a*; *b*, a frustule more magnified). Prepared frustules colourless, distinct keel present; valves without markings under ordinary illumination; breadth 1-1500 to 1-1200″.

This common species forms long, slightly curved chains, and, on account of the great breadth of the frustules, shows well the various stages of subdivision. The filaments are sometimes stipitate.

M. Borreri, Grev. Prepared frustules dark brown, ends rounded, entire surface punctate (ordin. illum.), no striæ nor keel; breadth 1-850 to 1-500″.

M. Dickiei (*Orthosira Dickiei*, Thw.) (Pl. 17. fig. 15: *a*, front view; *b*, side view). Filaments short, frustules nearly colourless, ends flat, no striæ nor keel (ord. illum.), valves thickened so as to render the cavity of the frustules rounded; breadth 1-1500 to 1-1200″.

The remarkable sporangia formed in this species (Pl. 10. fig. 9) are noticed under DIATOMACEÆ, p. 249.

** *Freshwater.*

M. (*Orthosira*) *varians* (Pl. 17. fig. 6, front view; *a*, side view). Frustules colourless, ends slightly convex and striated at the margin (ord. illum.), keel absent; breadth 1-1500 to 1-1200″. The end view of the frustules resembles that of *Cyclotella*.

Formation of sporangia shown in Pl. 10. fig. 8 *a*; *b*, sporangial frustule.

M. arenaria. Ends of frustules flat and striated at the margin (ord. illum.), the striæ appearing also in the front view; keel absent; frustules broader than long; breadth 1-660 to 1-260″.

M. crenulata, Kg. (*Aulacosira crenulata*, Thw.; *M. orichalcea*, Ralfs) (Pl. 10. fig. 7 *a*, forming sporangia; *b*, *c*, sporangial frustules). Differs from the last in its less diameter, and the frustules being two or three times as long as broad; breadth 1-1400″.

BIBL. Kütz. *Bacill.* 52, *Sp. Alg.* 27; Ralfs, *Ann. N. H.* 1843, xii. 346; Thwaites, *ibid.* 1848, i. 168; Smith, *Br. Diat.* ii. 54; Rabenh. *Alg.* ii. 37; O'Meara, *Q. Mic. Jn.* ix. 150.

MELOXAN'THUS, Buckt.—A genus of Aphidæ. *M. salicis*. Black, legs orange, antennæ 7-jointed; on the willow. (Buckton, *Aphid.*, *Ray Soc.* ii. 21.)

MEMBRANES, UNDULATING.—These are said to be simple membranous bands, one margin only of which is attached, the other being free and exhibiting an undulatory motion. They are allied to and answer the same purpose as cilia. They are described as occurring upon the spermatozoa of salamanders and tritons; as forming longitudinal processes in the water-vessels of some Anellida, as the Turbellaria; also as existing in some Infusoria, as *Trichodina*, and some Rotatoria. Some authors have regarded them as consisting of rows of cilia or a spiral fibre, and not membranes. They are most easily examined in the spermatozoa of the triton, in which we believe

the appearance of an undulating membrane arises from the existence of a fibre coiled around the spermatozoa, and undulating throughout its length (Pl. 50. fig. 17). This opinion is based upon the circumstance that if the coiled fibre be detached from the proper filament of a spermatozoon or spermatozoid, no margins of the (lacerated) membrane can be detected other than that visible at first, and which really represents the coiled fibre. This, however, is an interesting subject for further investigation. Siebold, who has paid most attention to it, remarks that *Trypanosoma Grubii*, a supposed entozoon found in the blood of frogs and fishes, is not an independent animal, but simply an undulating membrane swimming freely.

Bibl. Siebold, *Sieb. und Köll. Zeitschr.* Bd. ii. 356, *and the Bibl. therein.*

See Mucous and Serous Membranes.

MEMBRANIP'ORA, Johnst.—A genus of marine Polyzoa, family Membraniporidæ.

Several British species; usually found incrusting sea-weeds, more rarely shells and stones.

M. pilosa (Pl. 41. fig. 18). Orifices of the cells with one long hair, and several spinous teeth. Very common.

MEMBRANIPOREL'LA, Blainv., = *Lepralia*, pt. (Hincks, *Polyz.*).

MEMBRANIPOR'IDÆ.—A family of Cheilostomatous Infundibulate Polyzoa.

Distinguished by the expanded, incrusting, stony polypidom, and the horizontal quincuncial cells. Genera:

Membranipora. Cells open in front, with raised margins.

Lepralia. Cells closed in front, polypidom spreading circularly.

Bibl. Johnston, *Br. Zooph.*; Busk, *Cat. Mar. Polyz.*; Gosse, *Mar. Zool.* ii. 16; Hincks, *Polyz.* 127.

MENI'PEA, Lamx.—A genus of Infundibulate Cheilostomatous Polyzoa, family Cellulariadæ.

Char. Cells oblong, tapering downwards, not perforate behind, with one or two sessile birds'-heads in front below the orifice. Two British species.

M. ternata (*Cellularia ternata*, Johnst.). Cells elongated, greatly tapering downwards, 3 in each internode, with a stalked operculum protecting the orifice; operculum expanded, entire, two spines on the upper margin; anterior birds'-head single.

Bibl. Johnston, *Br. Zooph.* 335; Busk, *Cat.* 20; Hincks, *Polyz.* 36.

MENIS'CIUM.—A genus of Grammitideæ (Polypodiaceous Ferns).

10 sp.; tropical. (Hook., *Syn.* 390.)

MENISCOS'TOMUM, Kt.—A genus of Holotrichous Infusoria. Like *Paramecium*, but mouth lateral, lunate; with a vibratile membrane. 1 sp.; fr. wat. (Kent, *Inf.* 539.)

MENIS'PORA, Pers.—A genus of Mucedines (Hyphomycetous Fungi), one species of which, *M. lucida*, Corda, is recorded as British, growing on decayed wood.

Bibl. Berk. and Broome, *Ann. N. H.* 2 ser. vii. 101; Corda, *Ic.* i. pl. 4. fig. 223.

MENOID'IUM, Perty.—A genus of Flagellate Infusoria.

Char. Small, crescentic, thicker on the outer margin, colourless, or greenish.

M. pellucidum, freshwater; movement jerking and revolving, 1-670 to 1-430″.

Bibl. Perty, *Lebensf.* 174.

MENOPON, Nitzsch.—A subgenus of Liotheum (Anoplura); with the head semilunar or trapezoidal, but without a deep lateral sinuosity. The species infest poultry, the partridge, quail, &c.

MEREN'CHYMA.—A name applied by some authors to the form of vegetable cellular tissue where the cells are of circular, ellipsoidal, or irregularly rounded outline; ordinarily known as lax parenchyma.

MERID'ION, Leibl.—A genus of Diatomaceæ.

Char. Frustules (in front view) wedge-shaped, united laterally so as to form segments of circles or spiral bands. Fr. wat.

Frustules in side view obovate, and furnished with coarse transverse striæ visible under ordinary illumination, which extend into the front view.

Kützing distinguishes *Meridion*, in which the frustules form a spiral (helical) band, from *Eumeridion*, in which they form a convolute band.

Meridion circulare, Ag. (Pl. 17. fig. 7: *a*, front view; *b*, side view). Frustules in side view simply obovate, forming a spiral (helical) band or filament; length of frustules 1-600 to 1-375″.

Meridion constrictum, Kg. (Pl. 16. fig. 28, filament flattened, and frustules (front view) separated by drying: *a*, convolute filament; *b*, side view). Frustules in side view constricted near the broad end, attenuate towards the narrow end, and attached to a hemispherical stipes or cushion.

Bibl. Kütz. *Bacill.* 41, *Sp. Alg.* 10; Ralfs, *Ann. N. H.* 1843, xii. 457; Smith, *Br. Diat.* ii. 5; Rabenh. *Alg.* i. 295.

MERISMOPÆ'DIA, Meyen.—A genus of Confervoid Algæ, consisting of minute cells, arranged in fours and multiples, forming a quadrate layer or plate. Several species are described; but their relation to *Gonium* is obscure. *Sarcina* is placed in this genus by Rabenhorst; but *Sarcina* forms a cube. See SARCINA and GONIUM. (Rabenhorst, *Fl. Alg.* ii. 56.)

MERIZOMY'RIA, Ktz.—A genus of Rivulariaceæ.

Char. Filaments moniliform, upper cells subulate, basal cells contained in a mucous matrix, and constituting an amorphous thallus. Freshwater.

BIBL. Rabenh. *Fl. Alg.* iii. 224.

MERMIS, Duj.—A genus of Entozoa.

M. nigrescens resembles *Gordius*, but differs from it principally in the vulva of the female being transverse and situated near the anterior end of the body, whilst in *Gordius* this is placed at the posterior end. Eggs black.

It is found in the newly dug-up damp earth of gardens, and in the intestines of insects.

BIBL. Duj. *Ann. Sc. Nat.* 2 sér. xviii. 129, and *Helminthes*, 294; Siebold, *Ent. Zeit.* 1842, 146; Meissner, *Sieb. and Köll. Zeitschrift*, 1853.

MEROTRICHA, Mer.—A genus of Flagellate Infusoria. Free, oblong, green; flagellum single, ventral; with anterior trichocysts. 1 sp., freshwater. (Kent, *Inf.* 249.)

MERU'LIUS, Hall. Dry-rot.—A genus of Hymenomycetes (Basidiomycetous Fungi), distinguished by the veiny or sinuously plicate folds of the hymenium, these folds not being distinct from the flesh of the pileus, and forming angular or serrated pores. *M. lachrymans* is the dry-rot fungus. The mycelium is composed of filaments creeping in the substance of the infected wood, disorganizing and feeding on this as it decays. The mass is at first white and cottony, forming an effused pileus from 1 to 8″ broad; subsequently ferruginous or deep orange. The irregular folds finally discharge a watery liquid, whence the name.

The most efficacious remedies against dry-rot are creasote and carbolic acid. Corrosive sublimate, though at first efficacious, seems to lose its virtue after a time.

Several species of the genus have been found in England in addition to *M. lachrymans*.

BIBL. Berk. *Br. Fl.* ii. pt. 2, 129; Sowerby, *Fungi*, pl. 113.

MESOCARPUS, Hassall (*Sphærocarpus*, Kütz.).—A genus of Zygnemaceæ (Confervoid Algæ), with evenly distributed cell-contents, producing in conjugation a cross branch, in which is formed a round spore. It often happens that all the successive members of a long series of cells conjugate with another similar series, so as to produce a ladder-like body, the "rounds" of which are formed of the transverse processes (*trabeculæ*, Kütz.). The only kind of reproduction yet observed is that by the spores formed in the transverse branch from the conjoined contents of two cells; but it is possible that zoospores and encysted conditions of these occur, as in SPIROGYRA and MOUGEOTIA. The stellate encysted bodies found in most of the allied plants have been seen in *M. scalaris* by Thwaites. Thwaites also observed a division of the contents of the spore into four parts, such as occurs in ŒDOGONIEÆ.

M. scalaris, Hass. (fig. 138, p. 204). Sterile filaments 1-1800 to 1-1440″ in diameter, 6 times as long; sporanges oval or round. Hass. pl. 42.

M. depressus, Hass. Sterile filaments 1-2880 to 1-2400″ in diam., 6 to 8 times as long; spores globose or elliptical. Hass. pl. 44. fig. 1.

M. intricatus, Hassall, is apparently the same as *M. scalaris*; all the other forms may be brought under *M. depressus*.

BIBL. Hassall, *Alg.* 166, pls. 41–45; Kützing, *Sp. Alg.* 435; *Tab. Phyc.* v. (*Sphærocarpus*), pls. 5–7; Thwaites, *Ann. N. H.* xvii. 262.

MESOCE'NA, Ehr.—A doubtful genus of Diatomaceæ, according to Ehrenberg and Kützing.

The bodies referred to this title consist of single siliceous rings, oval or angular frameworks, without a centre, and mostly with external and sometimes internal spines arising from them; many are fossil.

Whether they are spicula of Echinodermata or not, remains to be decided. Diameter from 1-750 to 1-400″.

M. octogona, Ehr., Pl. 25. fig. 1.

BIBL. Ehrenberg, *Ber. Berl. Ak.* 1840; Kützing, *Bacill.* 139, *Sp. Alg.* 142.

MESO'CHRA, Boeck.—A genus of Copepodous Entomostraca, close to *Canthocamptus*. 2 species; brackish water. (Brady, *Copep.* ii. 62.)

MESODINIUM, Stein.—A genus of Peritrichous Infusoria. Free, ovate, snout-like in front, with a ring of setose cilia

2 species; freshwater and marine. (Kent, *Inf.* 635.)

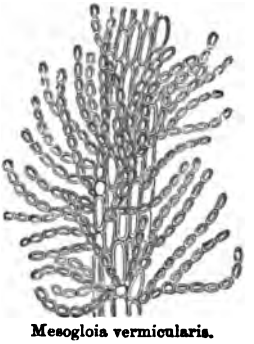
MESOGLO'IA, Ag.—A genus of Chordariaceæ (Fucoid Algæ), with filiform, much-branched, gelatinous fronds; the axis of the filaments composed of interlacing longitudinal cells, with gelatinous interposed matter; the periphery of radiating, dichotomous, coloured filaments. The fructification consists of unilocular and multilocular sporanges; the former are ovate sacs (fig. 458) occurring attached to the ramuli of

Fig. 458.

Mesogloia vermicularis.
Peripheral ramuli, unilocular sporanges and the filaments upon which the jointed sporanges arise.
Magnified 50 diameters.

the periphery; the latter are produced by ramifications of other ramuli surrounding them (fig. 458). Both kinds produce ciliated zoospores, which germinate. *M. vermicularis* (figs. 458, 459), an olive-green

Fig. 459.



Mesogloia vermicularis.
Portion of a filament.
Magnified 10 diameters.

or yellowish frond, 6″ high, is common on rocks and stones between tide-marks. *M. virescens*, a smaller species, is not uncommon.

Bibl. Harvey, *Mar. Alg.* 47, pl. 10 B; *Phyc. Brit.* pls. 31 & 83; Thuret, *Ann. Sc. Nat.* 3 sér. xiv. 237, pl. 27.

MESOTÆ'RIUM, Näg.—Probably identical with *Palmoglœa*. (Archer, *Qu. Mic. Jn.* iv. n. s. 109.)

METACY'PRIS, B. & R.—One of the *Cytheridæ*: carapace tumid and cordate; upper antennæ long and setose. Lakes and rivers of England, Ireland, and Holland.

Bibl. Brady and Robertson, *Ann. N. H.* 4, vi. 19; ix. 51.

METACYS'TIS, Cohn.—A genus of Holotrichous Infusoria.

Char. Free, ovate or elongate, ringed, vesicular behind.

M. truncata, among decaying marine algæ. (Kent, *Inf.* 511.)

METAMORPHOSES OF TISSUES.—The degenerations of the tissues, characterized by an alteration in their quality and impairment of function. They are divided into metamorphoses and infiltrations. The metamorphoses are characterized by the direct change of the albuminoid constituents of a tissue into a new material, which is usually followed by the destruction of the histological elements, and the softening of the intercellular substance. They include fatty, mucoid, and colloid degeneration.

Bibl. Green, *Path. and Morb. Anat.*

METEORITES.—In transparent sections of small fragments of meteorites, many mineral substances may be recognized here and there; but the microscope and even polarized light fail to distinguish the kinds of crystals. It is best to examine the bruised débris; and minute crystals may be sorted out, and removed for microscopic examination.

Bibl. Maskelyne, *Proc. Roy. Soc.* 1870.

METOPI'DES, Quenn.—Like *Metopus*, but with two or more posterior setæ. *M. contorta*, freshwater. (Kent, *Inf.* 582.)

METOPIDIA, Ehr.—A genus of Rotatoria, of the family Euchlanidota.

Char. Eyes two, red, frontal; foot forked; carapace depressed or prismatic; anterior and upper part of head naked or uncinate; no hood. = *Lepadella* with two frontal eyes. Lorica closed beneath.

M. triptera (Pl. 44. fig. 7). Carapace ovate, accurately trilateral, crested on the back. Freshwater; length 1-288 to 1-144″.

Four other species.

Bibl. Ehr. *Infus.* 477; Gosse, *Ann. N. H.* 1851, viii. 201.

METO'PUS, Clap. et Lach.—A genus of Heterotrichous Infusoria, fam. Bursarina.

Char. Buccal fossa oblique and elongate, anterior part of the body prolonged; anterior cilia stronger than those of the rest of the surface. *M. sigmoides* (Pl. 52. fig. 11).

Bibl. Claparède et Lach. *Inf.* 254.

METRID'IA, Boeck.—A genus of Copepodous Entomostraca. *M. armata*, marine. (Brady, *Copepoda*, i. 79.)

METZGE'RIA, Raddi.—A genus of Pelliese (Hepaticæ), comprehending *Jungermannia furcata*, L., and *J. pubescens*, Schrank, growing on trunks of trees, rocks, &c. in very moist places. The fronds of both are linear-dichotomous, membranous and ribbed. *M. furcata* is smooth above, hairy beneath; *M. pubescens* hairy on both sides and larger.

Bibl. Hook. *Br. Fl.* ii. pt. 1. 131; *Br. Jungerm.* pls. 55, 56, & 73; Endlicher, *Gen. Plant.* Supp. 1. 1338; Hofmeister, *Vergl. Untersuch.* 10, pl. 4.

MICA.—This mineral substance, which is often erroneously called talc in the shops, was formerly used for covering mounted objects, but is now replaced by thin glass. It is, however, occasionally useful in applying a red heat to objects, as Diatomaceæ, &c., where it is required not to change the position of the object. It often contains crystalline and crystalloidal inorganic mineral substances, as metallic oxides, &c., of interesting appearance.

Thin plates of mica are used also in bringing out colours in objects with polarized light. See Polarization, and Rocks.

MICRASTE'RIAS, Ag.—A genus of Desmidiaceæ (Confervoid Algæ).

Char. Cell single, lenticular, deeply divided into two-lobed segments; lobes inciso-dentate (rarely only bidentate), and generally radiating.

Sporangia spherical, with stout spines (Pl. 14. fig. 12).

Numerous British species (Ralfs).

M. denticulata (Pl. 14. fig. 11, undergoing division; fig. 12, sporangium). Cell circular, surface smooth; segments five-lobed; lobes dichotomously divided, ultimate subdivisions truncato-emarginate, with rounded angles. Length 1-113". Common.

M. rotata (Pl. 14. fig. 13). Cell circular, smooth; segments five-lobed; lobes dichotomously incised, ultimate subdivisions bidentate. Length 1-91". Common.

Bibl. Ralfs, *Br. Desmid.* 68; Lobb, *Tr. Mic. Soc.* 1861; Dixon, *Mic. Jn.* 1859; Archer, *Pritchard's Infus.*, & *Mic. Journ.* 1862; Bailey, *Smith. Contr.*; Rabenh. *Alg.* iii. 187.

MICROCLA'DIA, Grev.—A genus of Ceramiaceæ (Florideous Algæ), containing one rare British species, *M. glandulosa* (Pl. 4. fig. 7), with a dichotomously branched, filiform, compressed frond 1 to 2" high, of a bright rose colour. Its fructification consists of (1) roundish, sessile involucrated favellæ with *spores*, and (2) *tetraspores* (tetrahedrally arranged) imbedded in the ramules.

Bibl. Harvey, *Mar. Alg.* 160, pl. 22 B; *Phyc. Br.* pl. 29; Grev. *Alg. Br.* t. xix.

MICROCOC'CUS.—A genus of Schizomycetes, distinguished by the minute organisms being globular instead of linear. The species have been divided into 3 groups. The chromogenous: as *M. prodigiosus*, which is blood-red, and frequently occurs on Fungi, cooked provisions, red milk, &c. (see Blood on Bread); *M. luteus*, *cyaneus*, *violaceus* (elliptical), *aurantiacus*, on cooked potatoes and hard white of egg; and *M. chlorinus* on egg. The zymogenous, producing various kinds of fermentation, as *M. crepusculum* = *Monas c.*, Ehr.; *M. ureæ*, in *Torula*-form, 2–8, in urine, converting the urea into carbonate of ammonia, and decomposing hippuric acid. And the pathogenous, by some considered globular *Bacteria*, producing contagious diseases: as *M. vaccinæ*, in vaccine and variolous matter; *M. diphtheriticus*, oval, in twos or more, sometimes in colonies; *M. septicus* (*Micrococcus*, Klebs), in the tissues and vessels in pyæmia and septicæmia; *M. bombycis*, in the intestines of silkworms; and others, very doubtful, in the blood and sputum of measles, in scarlet fever, typhus, glanders, and syphilis. *Collarium*, Lk., seems, at least as regards some species, to be identical.

Bibl. *Bull. Soc. Imp. d'Agric.* 2 sér. vii. 727; *Comptes rendus*, 1852, 119; Cohn, *Beit.* i. 109, and ii. 148; Magnin, *Bactéries*; Hallier, *Phytopath.*

MICROCO'DON, Ehr.—A genus of Rotatoria, belonging to the family Megalotrochæa.

Char. Eye single; no carapace; foot styliform. Jaws two, each with a single tooth.

M. clavus (Pl. 44. fig. 8). Body companulate, foot equalling or exceeding the body in length. Fr. wat. Length 1-288 to 1-216".

Bibl. Ehr. *Infus.* p. 395.

MICROCO'LEUS, Desmaz. (*Chthono-*

blastus, Kütz.).—A genus of Oscillatoriaceæ (Confervoid Algæ), with fronds forming strata on moist ground, paths, mud, &c. These plants may be described as bundles of *Oscillatoria*-filaments enclosed in a common gelatinous sheath, which is simple or irregularly dichotomously branched, and forms twisted interwoven masses. The structure of the filaments appears to be identical with that occurring in OSCILLATORIA, described under that head; the filaments oscillate: the mode of origin of the enclosing sheath is obscure; but it would appear to be formed of the gelatinous half-dissolved outer membranes of the enclosed filaments. No formation of spores or gonidia has been described. *M. repens*, Harv. (Pl. 8. fig. 9*a*, the open end of a sheath), is very common on damp paths, &c., its sheaths are branched; *M. anguiformis*, Harv., occurs on the mud of brackish pools; its sheaths are said to be simple. *M. gracilis*, Hassall, said to be found in similar situations, has no character attached to it.

BIBL. Harvey, *Mar. Alg.* 227, pl. 26 D; *Phyc. Br.* pl. 249; Hassall, *Alg.* 260, pl. 70; Kütz. *Tab. Phyc.* i. pls. 54–58.

MICROCYS'TIS, Kütz.—A genus of Palmellaceæ (Confervoid Algæ), composed of crowded minute spherical cells, enclosed in a common envelope, forming solid families. *M. protogenita* (Pl. 3. fig. 12), bluish green, in long-kept water.

BIBL. Kütz. *Sp. Alg.* 208; *Tab. Phyc.* pls. 8, 9; Rabenh. *Alg.* ii. 51.

MICROGLE'NA, Ehr.—A genus of Infusoria, family Monadina, E.

Char. Tail absent; body truncated in front, with a single flagelliform filament; one or two red eye-spots present. Freshwater.

Probably the spores of Algæ.

M. punctifera (Pl. 31. fig. 43*a*). Body yellow, ovate, subconical, attenuate posteriorly, two red eye-spots accompanied by a blackish frontal spot; length 1-620″.

M. monadina (Pl. 31. fig. 43*b*). Body ovate, equally rounded at both ends, bright green; eye-spot red and single; length 1-1150 to 1-620″.

BIBL. Ehr. *Infus.* 25; Kent, *Inf.* 403.

MICROGONI'DIA. See MACROGONIDIA.

MICROGRO'MIA, Hert.—A genus of Reticularian Rhizopoda. The pseudopodia of different individuals unite, so as to produce colonies. (Hertwig, *Arch. mik. An.* x. *Suppl.* 1.)

MICROHALO'A, Kütz.—A genus of Palmellaceæ (Confervoid Algæ), consisting of microscopic gelatinous patches, floating in water, crowded with minute green gonidia. *M. Ichthyoblabe* (quite distinct from CLATHROCYSTIS) occurs in Britain; and Hassall's *Sorospora virescens* belongs here. Probably a *Chlorococcus*.

BIBL. Kütz. *Sp. Alg.* 207; *Tab. Phyc.* pls. 6, 7; Hassall, *Alg.* 326; Rabenh. *Alg.* iii. 60.

MICRO'MEGA, Ag., = SCHIZONEMA pt.

MICROM'ETER. See INTRODUCTION, p. xxviii, and MEASUREMENT.

MICROPE'RA, Lév.—A genus of Sphæronemei (Stylosporous Fungi), of which one species is described as British, *M. drupacearum* (*Cenangium Cerasi, junior*, Fr., *Sphæria dubia*, Pers.), growing on dead branches of the cherry-tree. It forms whitish tubercles which split the bark transversely, composed of somewhat cylindrical conceptacles, conjoined at the base, the white mealy ostiole projecting; the linear spores are yellowish and curved at the apex.

BIBL. Berk. and Broome, *Ann. N. H.* 2 ser. v. 380; Léveillé, *Ann. Sc. Nat.* 3 sér. v. 283; *Br. Flora*, ii. pt. 2. 211.

MICROP'ORA, Gray, = *Membranipora* pt. (Hincks, *Polyz.* 173.)

MICROPOREL'LA, Hincks, = *Lepralia* pt. (Hincks, *Polyz.* 204.)

MI'CROPYLE (of Animals). See OVUM.

MICROSCOPE.—The first Section of the INTRODUCTION consists of remarks upon the microscope and microscopic apparatus.

MICRO-SPECTROSCOPE. See SPECTROSCOPE.

MICROS'PORA, Thuret, = *Conferva* pt.

MI'CROSPORES.—The small kind of spores produced by Lycopodiaceæ and Marsileaceæ in contradistinction to megaspores or macrospores. When sown, they produce sperm-cells and spermatozoids.

MICROTHAM'NION, Näg.—A genus of Chætophoraceæ.

Char. Filaments much branched, rigid, jointed, narrow; joints longer than broad, slightly tumid. Propagation by zoogonidia. Freshwater.

BIBL. Rabenh. *Alg.* iii. 365.

MICROTHE'CA, Ehr.—A marine organism of doubtful nature.

It consists of yellow, flattened, rectangular (side view) bodies, with four equidistant spines projecting from each end; the colour arises from the contents; no

transverse line of division; entire length 1-216".

BIBL. Ehr. *Infus.* 164.

MI'CROZYMES, Béchamp.—The term applied to the minute particles or organisms producing fermentations, especially the pathogenous. Most of these bodies are considered to be forms or spores of Schizomycetes, referable to the genera *Bacterium*, *Bacillus*, and *Micrococcus*. Being very minute, they are with difficulty separated from the other constituents of the liquids in which they occur; and the process adopted by Chauveau and Sanderson to isolate and prove the action of the vaccine microzymes may be pointed out. The vaccine matter was placed in a very small test-tube, a little water gently added. The layer of leucocytes which subside first, was separated, and on vaccination found to be inactive. The remaining liquid was allowed to stand, when the soluble albuminous constituents diffused into the water, but the solution was innocuous; the zymome-layer was however found to be active.

BIBL. Béchamp, *Comp. rend.* 1868, *Qu. Mic. Jn.* 1868, 274; Sanderson, *Privy Council Rep.* 1869, 232; Hallier, *Phytopathol.* 1868; Roberts, *Q. M. Jn.* 1877, xvii. 307; Klein, *Qu. Mic. Jn.* 1878, xviii. 170.

MIELICHHOFE'RIA, Hornsch.—A genus of Bryaceous Mosses, containing one British species, *M. nitida*, sometimes referred to *Weissia* (fig. 81, p. 121).

MILI'OLA, Lamarck.—An extensive genus of Imperforate (Porcellaneous) Foraminifera, in which the chambers grow alternately on two or more sides of the long axis of the suboval shell: if on two sides, they form *Biloculina* (*B. ringens*, Pl. 23. fig. 3) and *Spiroloculina* (*Sp. planulata*, Pl. 23. f. 7), many and thin in the latter, few and thick in the former; if on three sides, they form *Triloculina* (*Tr. trigonula*, Pl. 23. fig. 4). Irregular development of the edges of the chambers gives rise to the many Quinqueloculine varieties (*Quinqueloculina seminulum*, Pl. 23. fig. 5; *Q. Brongniartii*, fig. 6)—from three to eight chambers being visible on one side, and from two to six on the other. *Uniloculina* (*U. indica*, Pl. 23. fig. 2) is possibly a young or arrested *Miliola*. *Cruciloculina* has a cross-slit opening, whilst the others have usually a crescentic aperture, owing to the presence of a tongue (homologue of the septum); but it may be round and produced.

In its young or Adelosine stage, *Miliola* differs from *Cornuspira* by its segmental stricture. See *M. obesa* junior, Schultze, Pl. 23. fig. 1. HAUERINA and FABULARIA are closely allied genera.

Fossil in all formations from the Trias upwards; and common in existing seas, chiefly in shallow water (*M. seminulum*, Pl. 23. fig. 5).

BIBL. Williamson, *Rec. For.* 78; Schultze, *Org. Polyth.* 57; Parker, *Tr. Mic. Soc.* n. s. vi. 53; Parker & Jones, *Ann. N. H.* 2, xix. 299; Carpenter, *Introd. For.* 74.

MILK.—This liquid consists of a solution of caseine and certain salts, holding in suspension minute globules of fatty matter (butter).

The fluid portion possesses no microscopic peculiarities. The globules are very numerous, round, and vary in size from mere molecules to 1-3000 or 1-2000" in diameter. Each is surrounded by a pellicle or coat of caseine, which prevents the globules from fusing into each other. If a portion of a drop of milk be placed upon a slide, and the thin glass cover be moved to and fro, the coat of caseine will be ruptured, the globules of oil will become confluent, and shreds of the coats will be visible. If acetic acid be added, the coats will be acted upon, and the confluence also produced. The same effect occurs naturally in sour milk; hence in this the globules are often much larger than the above dimensions, and irregular in form, frequently becoming elongated and united in twos, so as to bear some resemblance to the young state of a fungus.

The milk first secreted after parturition, called the colostrum, differs considerably from the normal liquid. The fatty globules contained in it vary greatly in size, often being very large, and existing within isolated or aggregated epithelial cells, some of them resembling exudation-corpuscles.

Peddie's paper on the human milk in relation to medical practice, is well worthy of perusal.

BIBL. Kölliker, *Mik. An.* ii.; Donné, *Cours de Micros.*; Wagner, *Hand. d. Physiol.* art. *Milch*; Peddie, *Ed. Mn. Jn.* 1840, and CHEMISTRY.

MILK-VESSELS. See LATICIFEROUS TISSUE.

MILLON'S TEST, or TEST-LIQUID.—This is a strongly acid (nitric and nitrous) solution of proto- and pernitrate of mercury, made by dissolving metallic mercury in its weight of strong nitric acid, with the aid of

heat. It gives a red colour to certain substances, gently boiled in it.

The following substances and tissues are coloured red by the test: albumen, caseine, chondrine, crystalline, epidermis, feathers, fibrine, gelatine, gluten, horn, legumine, proteine, silk, wool.

The following, when pure, are not coloured: cellulose, chitine, cotton, gum (arabic), linen and starch.

Bibl. Millon, *Compt. Rend.* 1849, or *Chem. Gaz.* 1849, vii. 87.

MILNE'SIUM, Doyère. — A genus of Arachnida, of the order Tardigrada (Colopoda).

Char. Head with two very short palpiform appendages at its anterior and lateral parts; mouth terminated by a sucker surrounded by palps; skin soft, transversely furrowed; legs four pairs; rings of the body divided into two segments.

M. tardigradum (Pl. 50. fig. 9). Mouth surrounded by six minute unequal palpi, symmetrically arranged, diminishing in size from the upper to the lower part; head rounded in front when the mouth is retracted; eye-spots tolerably large and granular; pharyngeal tube much dilated, styles very small, bulb elongated and pyriform, without an internal framework; body transparent, attenuated at both ends, especially the posterior; skin pale brownish yellow; three anterior pairs of legs nearly equal, the fourth very short, resembling two tubercles, with scarcely a trace of annuliform division; claws four, two terminal, and in the form of elongated filaments hooked at the end, and each supported on a distinct tubercle; two inferior and internal, the anterior divided into three strongly curved hooks, the posterior into two; hooks or terminal filaments of the fourth pair longer than those of the first three. Movement active. Length 1-50 to 1-40".

Bibl. Doyère, *Ann. Sc. Nat.*

MIMOSEL'LA, Hincks.—A genus of Ctenostomatous Polyzoa, fam. Vesicularidæ.

Char. Zoary confervoid, jointed, and branched; cells ovate, opposite, with a basal joint; animals with eight tentacles and a gizzard.

M. gracilis. Branches erect, arising from a creeping fibre. On sea-weeds.

Bibl. Hincks, *Polyz.* 555.

MINERALOGY, APPLICATION OF THE MICROSCOPE TO.—The following substances may be recognized in transparent minerals or blowpipe beads, by means of the characteristic absorption-bands seen in the spectrum, even when they are much coloured by the oxides of iron, manganese, or nickel, viz. didymium, erbium, uranium, cobalt, chromium, copper, manganese, and jargonia. In one method the substance is fused with borax or microcosmic salt, so as to give a clear bead, and the spectrum is examined by means of the spectrum eyepiece. In the other method, the saturated borax bead is kept hot over the lamp, so that crystals may be deposited in it. Many kinds of crystals may be thus distinguished. See SPECTROSCOPE and ROCKS.

Bibl. Sorby, *Qu. Mic. Jn.* 1869, 182.

MIRROR OF SŒMMERING. See INTRODUCTION, p. xxii.

MISCHOCOC'CUS, Näg. A genus of Palmellaceæ.

Char. Thallus gelatinous, branched; the terminal cells of the branchlets in pairs or fours. In boggy pools.

M. confervicola (Pl. 52. fig. 12).

Bibl. Rabenht. *Fl. Alg. Eur.* iii. p. 54.

MISTLETOE. See VISCUM.

MITES.—The animals usually included under this term are species of Acarina.

MITOPH'ORA, Perty.—A genus of Cilio-Flagellate Infusoria. Free, ovate, with a lateral row of parallel stout cilia, and a long terminal flagellum. *M. dubia*, freshwater. (Perty, *Lebens.* 153.)

MNIA'CEÆ.—A tribe of Mnioideæ (Mosses), of Bryoid habit, but with firm, rigid, and usually undulated leaves, mostly increasing in size toward the top of the stem. British genera: *Cinclidium*, *Georgia*, *Mnium*, and *Timmia*.

MNIADELPHA'CEÆ.—A family of Pleurocarpous Mosses, with the leaves arranged in four or more series, and composed of parenchymatous cells, mostly equally hexagonal and Mnioid, very smooth, pellucid, destitute of a distinct primordial utricle, the lowest decurrent on the stem at the base, larger, spongy, lax, mostly beautifully dark-tinged, never single, slender. Brit. genus:

Daltonia. Calyptra mitre-shaped, bell-shaped, elegantly fringed at the base. Peristome double (*Neckeroid*): outer, sixteen narrow, subulate, trabeculate teeth, reflexed when moistened; inner, an equal number of similar cilia, alternating with the teeth, devoid of a basilar membrane.

MNIOI'DEÆ.—A family of operculate Mosses, ordinarily of acrocarpous habit, but sometimes pleurocarpous, with broadly oval, spathulate, oval or lanceolate, flattish leaves,

having a very prominent, thick dorsal nerve. The base of the leaves composed of somewhat parallelogrammic cells, rounded-hexagonal or with equal walls towards the apex, very full of chlorophyll, or with the primordial utricle mostly very conspicuous, or much thickened, firm, rarely papillose. This family is divided into two tribes: MNIACEÆ and POLYTRICHACEÆ.

MNI'UM, Dill.—A genus of Mniaceous Mosses, of acrocarpous and pleurocarpous habit, including many *Brya* of the British Flora. Among the commonest is *M. hornum* = *Bryum hornum*, L.

MOCHA STONES.—The varieties of chalcedony known under this name contain a number of bodies (mineral dendrites) which have been mistaken for plants.

Compare AGATE, SILICA, and FLINT.

BIBL. K. Müller, *Ann. N. H.* 1843, xi. 415.

MOH'RIA, Swartz.—A genus of Schizæaceous Ferns.

M. thurifraga (fig. 460); Cape. (Hook. *Syn.* 436.)

Fig. 460.

Mohria thurifraga.
A pinnule with sporanges.
Magnified 25 diameters.

MOI'NA, Baird.—A genus of Entomostraca, order Cladocera, and family Daphniadæ.

Char. Head rounded and obtuse; superior antennæ of considerable length, of one piece, and arising from the front of the head near the middle; inferior antennæ large, fleshy at the base, and two-branched, one branch three-jointed, the other four-jointed; legs five pairs. Freshwater.

M. rectirostris (Pl. 19. fig. 23). Carapace almost straight or but slightly rounded behind.

M. brachiata or *branchiata.* Carapace greatly rounded behind.

BIBL. Baird, *Br. Entomos.* 100; Grobben, *Entw., Jn. Mic. Soc.* iii. 77.

MOIST CHAMBER.—Introduced by Recklinghausen, improved by Schultze and others; it enables the object under microscopic examination to be placed in a space saturated with moisture, and to be examined without or with the intervention of thin glass. Also it enables an immersion-lens to remain with its water in contact with thin glass over an object in any liquid for a considerable time. The simplest form is that of a large glass ring cemented to a broad glass plate; a thin and flexible caoutchouc membrane is fixed to the ring and to the object-glass by india-rubber rings. The growing-slide mostly answers the same purpose. See Frey, *Mik.* 63; Rutherford, *Hist.* 150; Dallinger and Drysdale, *M. M. Jn.* xi. 97.

MOLECULAR MOTION.—When extremely minute particles of any substance immersed in water or other liquid are examined under the microscope, they are seen to be in a state of vivid motion. A little gamboge or Indian-ink mixed with water will exhibit the phenomenon distinctly enough. The minute particles or molecules are seen to move irregularly, to the right and left, backwards and forwards, as if repelled by each other, until the attraction of gravitation ultimately overcomes the force upon which their motion depends, when they sink to the surface of the slide. This applies to the molecules of those substances which are heavier than water. In the case of those which are lighter than water, or the liquid in which they are immersed, the molecules ultimately become adherent to the thin glass covering the slide.

This motion is in no way connected with evaporation, for it takes place equally when this is completely prevented, just as when it is not. Neither light, electricity, magnetism nor chemical reagents exert any effect upon it. Heat is the only agent which affects it; this causes the motion to become more rapid. Hence it might be attributed to the various impulses which each particle receives from the radiant heat emitted by those adjacent. Or, as it takes place when the temperature is uniform, may it not arise from the physical repulsion of the molecules, uninterfered with by gravitation, hence free to move? The effect of heat would then be explicable, because this increases the natural repulsion of the particles of matter, as in the conversion of water into vapour.

Molecular motion plays a part in some

common phenomena. Thus, it prevents turbid water from becoming rapidly clear by repose; by its agency also the disaggregated particles of animal or vegetable matter are diffused throughout the mass of the liquid.

The microscopist should become acquainted with the appearance of particles in molecular motion, as it might give rise to error; and it often occurs in animal and vegetable cells. Thus particles under its influence might be mistaken for monads; or particles moved by cilia might be regarded as merely exhibiting this molecular motion.

Two circumstances appear most favourable for its production and continuance, in addition to the augmentation of temperature, viz. a very finely divided state of the matter, and the specific gravity of the matter and the liquid in which it is suspended being as nearly as possible coincident.

Bibl. Brown, *On Active Molecules* (*privately printed*); Duj. *Observ. au Mic.*; Griffith, *Med. Gaz.* 1843; Delsaulx, *M. Mic. Jn.* xviii. 1; Hartley, *ib.* 8; Jevons, *Qu. Jn. Sc.* 1878, 167; Ord, *Jn. Mic. Soc.* 1879, 656.

MOL'GULA, Forbes.—A genus of Tunicate Mollusca, of the family Ascidiadæ.

Two British species: *M. oculata*, adherent, bluish or purple, mottled with orange, 2½″ in diameter; and *M. tubulosa*, free, in sand.

Bibl. That of the family.

MOL'GUS, Duj., = *Bdella* pt. 2 species; on marine sands. (Dujardin, *l'Institut*, 1842, 316; Gervais, *Apt.* 158.)

MOLLUSCA.—Every portion of the structures of the Mollusca offers objects of interest to the microscopist. The motion of the cilia, the structure of the lining membrane of the viscera, the spermatozoa, the ovular growth and the nature of the sensory organs can be easily investigated. Remarks upon certain interesting structures occurring in the Mollusca will be found under Tongue, Shell, Snails (Water-), Mussel, Oyster, and Ovum. The calcareous concretions, crystals, and spicula met with in the integument or mantle of some mollusca are curious.

Bibl. Siebold, *Vergl. An.* and the copious Bibl.; Vogt, *Zool. Briefe*; Adams, *Recent Mollusca*; Forbes and Hanley, *Br. Mollusca*; Woodward, *Shells*; Jones, *An. Kingdom*, and *Cycl. of An. and Phys.*; Huxley, *Comp. Anat.*, and *Engl. Cyclop.*; Deshayes, *Hist. Nat. Moll.*; Turton, *Br. Shells, by Gray*; Jeffreys, *Br. Conch.* (*figs. of all species*, mar. and frw.); Rimmer, *Br. fd. and freshwater Shells.*

MONACTI'NUS, Bail.—A genus of Desmidiaceæ = Monactinium, Braun.

Distinguished from *Pediastrum* by the marginal cells having one horn only. Species:—*M. octonarius*: marginal cells eight, central none. *M. duodenarius* (Pl. 36. fig. 28): marginal cells twelve, central three.

Bibl. Bailey, *Smith. Contr.* 1853, 14; Rabenh. *Aly.* iii. 71.

MONADI'NA.—A family of Infusoria, according to Ehrenberg's system, but consisting of a heterogeneous group of imperfectly examined bodies.

Char. Carapace absent; no expansions; locomotive organs consisting of one or more flagelliform filaments or cilia at the anterior part of the body.

Ehrenberg distinguishes nine genera:

A. Tail none.
  a. No lips.
    α. Swimming.
      α. No eye-spot.
        Single ..... 1. *Monas.*
        Grouped ..... 2. *Uvella.*
      β. Eye-spot present.
        Single.
          * Flagelliform filaments one or two ..... 3. *Microglena.*
          ** Flagelliform filaments four or five ..... 4. *Chlorastor.*
          *** Flagelliform filaments numerous ..... 5. *Phacelomonas.*
        Grouped ..... 6. *Glenomorum.*
    b. Rolling ..... 7. *Doxococcus.*
  b. Lips present ..... 8. *Chilomonas.*
B. Tail present ..... 9. *Bodo.*

Dujardin divides them thus:

MONADINA.

Isolated.
- A single flagelliform filament
  - arising from the anterior extremity of the body
    - moving throughout its whole length ..... 1. *Monas.*
    - thicker and rigid at the base, moveable at the end ..... 2. *Cyclidium.*
  - arising obliquely from behind an anterior prolongation ..... 3. *Chilomonas.*
- A second filament,
  - lateral ..... 4. *Amphimonas.*
  - posterior ..... 5. *Cercomonas.*
- Two equal filaments terminating the curved angles of the anterior end ..... 6. *Trepomonas.*
- Four equal filaments in front, and two thicker ones behind ..... 7. *Hexamita.*
- A second filament arising from the same spot as the flagelliform filament, but thicker, trailing and retracting ..... 8. *Heteromita.*
- A filament and vibratile cilia ..... 9. *Trichomonas.*

Aggregate.
- Groups always free, revolving ..... 10. *Uvella.*
- Groups originally fixed at the end of a branched polypidom or stalk ..... 11. *Anthophysa.*

Dujardin's characters are:—animalcules without an integument, consisting of a glutinous, apparently homogeneous substance, susceptible of becoming agglutinated to other bodies, and so drawn out and altered in form, with one or more flagelliform filaments as locomotive organs, and sometimes lateral or tail-like appendages.

Bibl. Ehr. *Infus.* 1; Duj. *Infus.* 270; Dallinger, *M. M. Jn.* xiii. 185; Cienkowski, *chultze's Arch.* xii. 227.

MONADS are species of *Monas*, or other Monadina.

MONAS, Müll.—A genus of Infusoria, of the family Monadina.

M. Dallingerii. Ovate, pointed, no nucleus nor contractile vesicle; length 1-4000″. In fish- (cod) macerations. Propagation by transverse fission; and by spores after conjugation and encystment. The germs of these monads survive a temperature which destroys the adults.

M. vinosa, E. Ovate, uniformly rounded at each end, of a red-wine colour, motion slow and tremulous. Length 1-12,000 to 1-6000″.

Found upon the sides of glass vessels in which decaying vegetable matter has been kept, on the side next the light.

M. lens, D. (Pl. 31. fig. 44 *a*). Body rounded or discoidal and tubercular. Breadth 1-5200 to 1-1800″.

One of the most common organisms in animal and vegetable infusions. We have found one common in animal infusions (Pl. 31. fig. 44 *b*), perhaps the same as the above; but it possesses usually two filaments: on the left side is one without filaments, but with the body drawn out from adhesion to the slide.

M. attenuata, D. (Pl. 31. fig. 44 *c*). Body ovoid, narrowed at the ends, nodular, unequal; filament arising from the anterior narrowed portion. Length 1-1600″. Very abundant in fetid films floating on water containing decaying freshwater Algæ.

M. prodigiosa, see Micrococcus.

Several other species; many probably consisting of the zoospores of Algæ, or the swarm-germs of other Infusoria.

Bibl. Ehr. *Infus.* 3; Duj. *Infus.* 279; Kent, *Inf.* 232.

MONE'RA, Haeckel.—A group of Protista, forming the simplest of all organisms, the protoplasm or sarcode constituting the whole structureless body; nuclei and cell-membranes are never developed. The Monera are subdivided into Gymnomonera and Lepomonera. The Gymnomonera do not pass into a quiescent or resting condition, and do not surround themselves with a covering, and propagate by fissiparous division. The Lepomonera pass into a resting stage, and surround themselves with a covering for the purposes of reproduction—breaking up into spore-like bodies, which, on escaping, resemble the parent form.

Bibl. Cienkowski, *Schultze's Arch.* 1865, i. 203; Haeckel, *Zeit. wiss. Zool.* 1865, xv. 360; *Gener. Morph. Jenai. Zeit.* 1868, iv.; Wright, *Qu. Mic. Jn.* 1869.

MONOCER'CA, Bory.—A genus of Rotatoria, of the family Hydatinæa.

Char. Eye red, single, cervical; foot-like tail simply styliform.

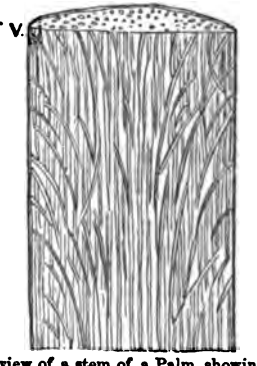
Gosse mentions a second eye situated in the breast of one species. Ehrenberg describes three species, to which Gosse adds two.

M. rattus, E. (Pl. 44. fig. 9). Body ovate-oblong; forehead truncate, unarmed; foot styliform, as long as the body. Aquatic. Length 1-120″.

Bibl. Ehr. *Infus.* 422; Gosse, *Ann. N. H.* 1851, 199.

MONOCOTYLE'DONS. — One of the classes of Angiospermous Flowering Plants,

Fig. 461.



Reduced view of a stem of a Palm, showing the perpendicular and horizontal section, in which the fibro-vascular bundles F.V are seen isolated in the medullary parenchyma.

so called from the structure of the embryo contained in the seed, which in a large number of cases is of microscopic dimensions, and always requires the use of the simple microscope for its dissection. Some of the families placed under this head have usually an acotyledonous embryo, as Orchidaceæ;

but these possess the character of the class in all other respects. Among the most important of their other characters is the isolated condition of the fibro-vascular bundles forming the woody structures (see TISSUES, VEGETABLE). This character, mostly very evident both in perpendicular and horizontal sections of the stems, is illustrated by figs. 456 & 461.

MONOGRAM'MA, Schk.—A genus of Grammitideæ, consisting of small grass- or rush-like plants, the simplest in structure of all the Ferns. Several species, tropical. (Hooker, *Synops.* 374.)

MONOL'ABIS, Ehr.—A genus of Rotatoria, of the family Philodinæa.

Char. Eyes two, frontal; tail-like foot with two toes; horns absent.

Two species.

M. gracilis (Pl. 44. fig. 10). Body slender, no cervical process nor respiratory tube; teeth two in each jaw; freshwater. Length 1-240 to 1-144″.

BIBL. Ehr. *Infus.* 497.

MONOR'MIA, Berkeley.—A genus of Nostochaceæ (Confervoid Algæ), with a definite, linear, convoluted frond, enclosing a single moniliform filament; differing from *Nostoc* in the convoluted frond being devoid of the common membranous pellicle. *Monormia intricata* occurs in gelatinous masses, about as large as a walnut, of a reddish-brown colour, floating in slightly brackish ditches. When the spermatic cells are quite mature, the definite outline of the linear frond is almost lost, and there is little to distinguish the plant from *Trichormus*, except the peculiar convolutions of the moniliform filament; the frond then also assumes a greenish tint.

BIBL. Berk., *Glean. of Br. Algæ*, t. 18; Ralfs, *Ann. N. H.* ser. 2. vol. v. pl. 8. fig. 1; Harvey, *Phyc. Br.* t. 256; Hassall, *Algæ*, t. 75. fig. 11. *Nostoc intricatum*, Meneghini, *Anabæna intricata*, Kütz., *Tab. Phyc.* i. t. 94. fig. 1; Rabenhorst, *Alg.* ii. 183.

MONOSI'GA, Kt.—A genus of Choanoflagellate Infusoria.

Char. Bodies naked, solitary, sessile or stalked, with a single flagellum, and an anterior funnel-shaped collar composed of sarcode. Nine species, freshwater and marine; l. 1-5000 to 1-2500″. (Kent, *Infus.* 329.)

MONOSPI'LUS, Sars.—A genus of Lynceidæ (Entomostraca).

Char. Carapace of series of superimposed valves; head depressed; no compound eye.

BIBL. Norman and Brady, *Mon. Nat. Hist. Tr. Northumb.*

MONOSTE'GIA, D'Orb.; MONOTHALA'MIA, Schultze.—Instituted as an order; but one-chambered Foraminifera are found in most of the chief families, and therefore cannot constitute a separate group. Thus *Proteonina, Squamulina, Cornuspira* (Pl. 23. fig. 13), *Uniloculina* (Pl. 23. fig. 3), *Trochammina* (Pl. 23. fig. 14), *Saccammina, Astrorhiza, Lagena* (Pl. 23. figs. 22-27), *Ovulites, Orbulina* (Pl. 24. fig. 1), and *Spirillina* (Pl. 24. fig. 5) are either usually or constantly unilocular.

MONOSTRO'MA, Thuret.—A genus of Ulvaceæ (Confervoid Algæ), of which *M. bullosum* (*Ulva bullosa*, Roth) is the type, distinguished from *Ulva* by consisting only of a single layer of cells, and these being roundish (mostly grouped in fours), imbedded in an apparently homogeneous gelatinous membrane (Pl. 9. fig. 1 *a*). This plant is reproduced by zoospores formed from the cell-contents, and discharged by bursting of the cell-wall (fig. 1 *b*, *c*). They have four cilia.

Currey has described, under the name of *M. roseum*, a plant which we think scarcely referable here, but rather to MICROCYSTIS.

BIBL. Thuret, *Ann. Sc. Nat.* 3 *sér.* xiv. 225, pl. 21. figs. 1-4; id. *Mém. Soc. Scient. de Cherbourg*, ii. 1, 1854.

MONOSTY'LA, Ehr.—A genus of Rotatoria, of the family Euchlanidota.

Char. Eye single, cervical; tail-like foot simply styliform; carapace depressed.

Four species: three, Ehrenberg; and one other, Gosse.

M. quadridentata (Pl. 44. fig. 11). Carapace yellowish, fore part of head deeply cleft in four horns; freshwater. Length 1-120″.

BIBL. Ehr. *Infus.* 459; Gosse, *Ann. N. H.* 1851, viii. 200.

MONOTOS'PORA, Corda.—A genus of Dematiei (Hyphomycetous Fungi), of which one species has been found in England, growing on dead bark of the yew. *M. megalospora*, Berk. and Br. Filaments erect, simple, straight, nearly equal, articulated. Spores terminal, obovate, even, ·00133 to ·0014″ long. Fries regards this genus with doubt.

BIBL. Berk. and Broome, *Ann. N. H.* 2 ser. xiii. 462, pl. 15. fig. 11; Fries, *Sum. Veg.* 497.

MONSTRIL'LA, Dana.—A genus of Copepodous Entomostraca. *M. Anglica*;

Weymouth. (Lubbock, *Ann. N. H.* 1857, xx. 401; Brady, *Cop.* iii. 37.)

MONTAGNITES, Fr. — A genus of Agaricini (Hymenomycetous Fungi), distinguished by the dry gills which project after the universal volva breaks off from the edge of the pileus.

One species occurs in the south of France and Algeria, another in Texas, and a third in Siberia, in dry sandy soil; extremely interesting as connecting the Hymenomycetes with the Gasteromycetes.

Bibl. Fr. *Ep.* 241; *Fl. Alg.* t. 21. f. 2.

MONU'RA, Ehr.—A genus of Rotatoria, of the family Euchlanidota.

Char. Eyes two, frontal; foot simply styliform. Carapace somewhat compressed and open beneath.

Two species.

M. dulcis (Pl. 44. fig. 12). Carapace ovate, obliquely truncate and acute behind; eyes distant. Length of carapace 1-280".

Bibl. Ehr. *Infus.* 474.

MOOR'EA, J. & Kirkby.—A fossil Ostracode, known by its suboval depressed valves, with raised margins. Found in Silurian and Carboniferous rocks.

Bibl. Jones & Holl, *Ann. N. H.* 4. iii. 225.

MORCHEL'LA, Dill.—A genus of Ascomycetous Fungi, distinguished by its stipitate receptacle, which is deeply folded and pitted.

Four species occur in this country, amongst which *M. crassipes* is the giant of the genus. The species are esculent, and largely imported. They are very abundant in some parts of India, especially in Kashmir. They often occur on cinder walks and burnt soil.

Bibl. Grev. *Crypt. Fl.* tab. 68, 89; Berk. *Outl.* t. 21. f. 5; Cooke, *Handb.* 655.

MORPHIA. See Alkaloids, p. 31.

MORPHO, Fabr.—A genus of Exotic Lepidopterous Insects.

M. Menelaus. The scales from the wings of this beautiful insect are sometimes used as Test-Objects.

MORTIEREL'LA.—A genus of Mucedines, with branched threads like a candelabrum, on the underside of which sporangia are produced; zygospores have also been found. Moulds of great elegance. *Martensella*, an allied genus, has pectinate sporangia. (Coemans, *Bull. Ac. Belgiq.* xv. 544; Bary & Woronin, *Beit.* 4; Brefeld, iv. figs.)

MOSSES, MUSCACEÆ.—This order of flowerless plants is distinguished from the Hepaticæ by the vegetative structure and by the sporanges. In one group alone (*Hypopterygieæ*) is the stem clothed with leaves, accompanied by amphigastria (stipule-like leaflets), in the manner of the foliaceous Hepaticæ (fig. 355, p. 409): and here the sporange is a stalked urn-shaped body, with a deciduous lid, and like those of the Mosses generally; and this Jungermannia-like leafy stem is *erect*, and not procumbent as in *Jungermannia* itself. In all other Mosses the leaves clothing the stem are arranged in a spiral order around the stem, so as to give the vegetative structure a very characteristic aspect. On the other hand, the Andræaceæ, which have a valvate capsule, have spirally-arranged leaves.

The stem of the Mosses is a slender thread-like wiry structure, wholly composed of cellular tissue, without vessels; but the external layer has an epidermoid character, while the central portion is composed of elongated cells. In one section of the Mosses this stem terminates in a sporange, and these are called *Acrocarpous* Mosses; in others the sporanges spring from lateral branches, and the terminal bud of the stem elongates the stem year after year; these latter are called *Pleurocarpous* Mosses. In some of the genera the sporanges are borne terminally on short special branches, as in *Sphagnum*, *Mielichhoferia*, part of *Fissidens*, *Guembelia fontinaloides* (fig. 289, p. 366); these are termed *Cladocarpous*.

Fig. 462.

Ephemerum serratum. Leaf. Magn. 50 diams.

The leaves are of simple structure, usually composed of a single layer of cells, the forms of which are used as characters by systematic Muscologists. They are either all alike in a leaf, and filled with chlorophyll, and in these cases may be either *parenchymatous* (Pl. 47. fig. 19) or *prosenchymatous* (Pl. 47. fig. 20). In other cases two sorts of cells occur arranged in a peculiar way; some, smaller, containing chlorophyll, form a kind of network, the meshes of which are occupied by large uncoloured cells (see Sphagnum and Leucobryum).

The margins of the leaves are frequently serrated; and the upper surface is occasionally papillose, or covered with rough points,

Many of them have one or more distinct nervules, composed of elongated cells, often not reaching the apex of the leaf.

The leaves often differ on different parts of the stem; and we hence have *radical*, *cauline*, and *perichætial* or involucral leaves, the last ordinarily forming a kind of rosette, in the midst of which the reproductive organs are produced. SCHISTOSTEGA exhibits two forms of stems, with two kinds of foliaceous structure: the stems which terminate in a sporange have leaves only at the upper part, and these arranged in eight rows standing crosswise on the stem, like ordinary leaves; the barren stems have two rows of leaflets arranged in one plane on the stem, like the leaflets of a compound leaf (such as that of the Acacias) of Flowering plants. The stem-leaves of many genera exhibit wing-like structures, hair-like appendages, or peculiar forms of curvature (figs. 242–246, FISSIDENS); others, like

Fig. 463. Fig. 464.

Barbula chloronotus.

Fig. 463. Leaf with cellular filaments at the tip. Magn. 30 diams.

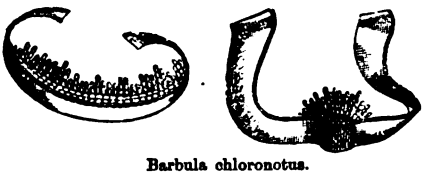
Fig. 464. Leaf with cellular filaments crowded on the midrib, with an awn-like prolongation. Magn. 20 diams.

certain *Barbulæ* (figs. 463–466), have collections of cellular filaments on the upper-side.

The outer leaves surrounding the reproductive organs are called *perichætial*, and sometimes they form the only envelopes; sometimes, however, a few small leaves, differing very much from the above, form the immediate envelopes of the archegones; and these *perigonial* leaves, forming the perigone, are developed *after* the reproductive organs themselves (as is the case also with the *perigone* of the Hepaticæ). The perigonial leaves either overlap and cover-in the reproductive organs, or they are keeled at the base and turned back above, so as to expose the organs of reproduction (POLYTRICHUM).

The Mosses have no roots, their function

Fig. 465. Fig. 466.



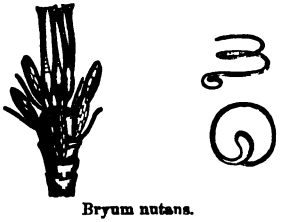
Barbula chloronotus.

Fig. 465. Cross-section of 463. Magn. 50 diams.
Fig. 466. Cross-section of 464. Magn. 50 diams.

being performed by root-hairs or rhizoids, usually brown.

The young reproductive organs consist of *antheridia*, and *archegonia* or *pistillidia*, which are found either together (fig. 467),

Fig. 467. Fig. 468.



Bryum nutans.

Fig. 467. Inflorescence of antheridia and archegonia. Magn. 25 diams.
Fig. 468. Spermatozoids from antheridia. Magn. 600 diams., the cilia omitted.

or on different parts of the same plant, or on different individuals of the same species.

Fig. 469.

Mnium arcticum.
Antheridial inflorescence.
Magnified 25 diameters.

To these structures the term *inflorescence* is applied. The antheridia occur either with the archegones in one perigone (fig. 467) or

in the axils of the upper leaves of the stem, which terminates in a perigone containing archegones; or they have a special perigone (fig. 469), either on the same plant, or on a different one from that which bears the archegones. The antheridia are globular, oval (fig. 467), or elongate membranous sacs composed of cellular tissue, red or

Fig. 470. Fig. 471.

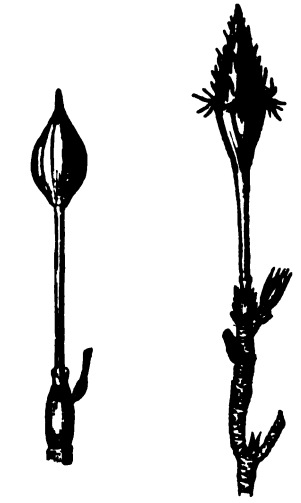


Fig. 472. Fig. 473.

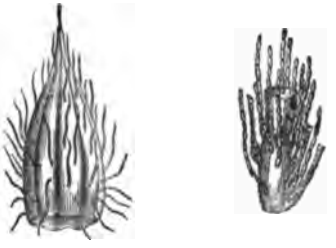


Fig. 470. Cosinodon pulvinatus. Capsule enclosed in the calyptra, with the vaginule below. Magn. 10 diams.
Fig. 471. Orthotrichum Hutchinsii. Capsule covered by the calyptra, with the vaginule below. Magn. 10 diams.
Fig. 472. Ditto. Calyptra. Magn. 25 diams.
Fig. 473. O. stramineum. Vaginule. Magn. 25 diams.

yellow when ripe, filled with minute cells, which escape by the bursting of the apex of the sac; and these cells exhibit a fibre coiled in their interior, which circulates rapidly, even before the expulsion from the antheridium, and after a time breaks out of its cell (fig. 468, and Pl. 40. fig. 33), and moves rapidly in the water under the microscope (see ANTHERIDIA). The antheridia are generally accompanied by cellular filaments which have received the name of *paraphyses* (fig. 23, p. 57); no physiological office is attributed to these; but the antheridia are the male organs.

The *archegone* of the Mosses (figs. 30, 31 (p. 71), 467), like that of the Hepaticæ (excepting *Anthoceros*), is a flask-shaped cellular case, the epigone, containing an *embryonal cell* at the bottom of its cavity. This embryonal cell becomes gradually developed by cell-division into a conical body elevated on a stalk, which at length tears away the walls of the flask-shaped epigone by a circular fissure, and carries the upper part upwards as a hood, while the lower part remains as a kind of collar round the base of the stalk (figs. 470–472); the latter is termed the *vaginula* (fig. 473); the cap-like portion carried upwards on the sporange is called the *calyptra* (figs. 470–472). The *sporange*, elevated more or less by the

Fig. 474. Fig. 475.

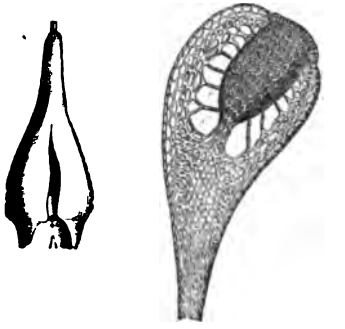


Fig. 474. Tayloria serrata. Dimidiate calyptra. Magn. 25 diams.
Fig. 475. Funaria hygrometrica. Section of young capsule, showing the columella. Magn. 50 diams.

development of its stalk (*seta* or *peduncle*), is gradually converted by internal changes into a hollow urn-like case, usually with a stalk-like column (*columella*) running up its centre (figs. 50, 475), the space between the central column and the side walls becoming filled with free *spores*, which are minute cells with a double coat, the outer of which exhibits elegant markings (see SPORES). In some cases this hollow case does not burst naturally, but the spores

escape by its decay (ASTOMUM, fig. 50). In the ANDRÆACEÆ (fig. 11, p. 41) the sporange bursts by vertical slits, so as to

Fig. 476. Fig. 477.

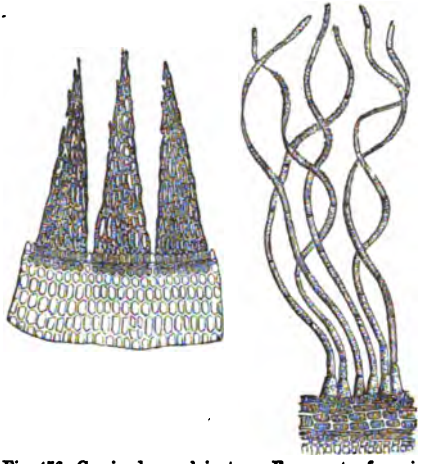


Fig. 476. Coscinodon pulvinatus. Fragment of peristome. Magn. 100 diams.
Fig. 477. Barbula flavipes. Fragment of peristome. Magn. 100 diams.

be divided into valves, as in the Jungermanniæ, and there is no *column* in the sporange here; but the valves do not separate at their summits, and the character of the leafy stem at once distinguishes these

Fig. 478. Fig. 479.

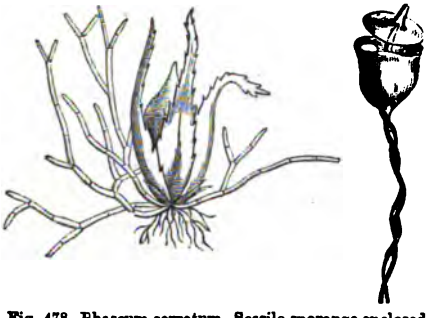
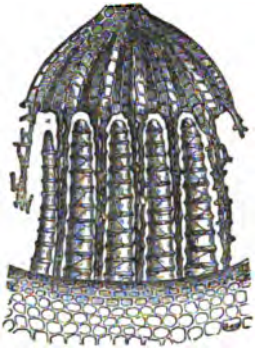


Fig. 478. Phascum serratum. Sessile sporange enclosed by few leaves. Magn. 15 diams.
Fig. 479. Pottia truncata. Operculum separating from the sporange. Magn. 10 diams.

Mosses from the Hepaticæ. The ordinary course, however, in the Mosses is the formation of a horizontal slit near the top of the sporange, so that the upper part falls off like a lid (*operculum*, fig. 479).

The sporange of the Mosses exhibits a very complex anatomical structure, which we have not space to enter into very minutely: it will suffice to state that the lower part next the peduncle is sometimes enlarged into a thickened mass, called the *apophysis*; sometimes the peduncle is very long, sometimes very short (*Phascum*, fig. 478), so that the sporange is hidden in the perichæte; finally, the mouth may either exhibit a smooth edge (fig. 479), or a single

Fig. 480.



Cinclidium arcticum
Part of double peristome, the inner processes united into a plaited membrane in the centre.
Magnified 100 diameters.

(figs. 476, 477) or double (figs. 483, 484) fringe of very variously constructed teeth, which are of great service in discriminating the genera. When the mouth of the sporange is naked, the Mosses are called *gymnostomous*, when furnished with only a single row of teeth *haploperistomous*. When a double peristome exists, the outer consists of *teeth*, the inner of *processes* or *cilia* (fig. 483) or of both (*Bryum*). The teeth sometimes arise directly from the mouth of the sporange, sometimes are seated on a basal membrane, sometimes connected together irregularly (FUNARIA, fig. 259, p. 342), or by regular bars (GUEMBELIA, fig. 291, p. 366), or the whole of the inner circle may be conjoined entirely (BUXBAUMIA, fig. 93, p. 126) or at the tips (fig. 480) into a membrane, or by a number of cross bars into an open trellis (fig. 484). The outer rows of teeth are continuations of the inner layers of tissue of the sporange (fig. 481);

where an inner circle occurs they are continuations of the spore-sac; the outer wall of the sporange is, as it were, continued by the *operculum*. Ordinarily these do not separate directly from each other when the lid falls off, since one or several layers of elastic cells, forming a ring (*annulus*, fig. 482) round the mouth, split out from between the sporange and its lid, and cause the latter to fall off.

The spores are developed in a distinct spore-sac, which has one layer next the wall of the capsule, and an inner layer next the columella. The top of the columella expands into a kind of pseudo-operculum in *Polytrichum*. In Phascaceæ the columella is absorbed.

Allusion has been made to the sexual import of the antheridia and archegonia. In the reproduction of the Mosses the spores produce a confervoid filament or *protonema*, from the sides of which the young plants with stem and leaves shoot; and on these the antheridia and archegonia are formed. From the embryo-cell of the fertilized archegonium arises the sporogonium, in which the spores are formed.

The Mosses exhibit a variety of forms of vegetative multiplication. The lower part of the stem often sends out horizontal branches, which root and produce buds (fig. 485), from which arise new leafy stems;

Fig. 481.

Fig. 482.

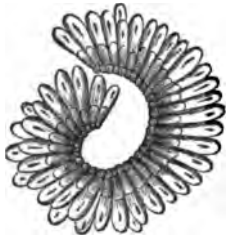


Fig. 483.

Fig. 481. Racomitrium fasciculare. Section of margin of sporange, with a tooth of the peristome. Magn. 100 diams.
Fig. 482. Bryum cæspiticium, annulus. Magn. 100 diams.
Fig. 483. Orthotrichum diaphanum. Portion of double peristome, the outer composed of teeth, the inner of cilia. Magn. 50 diams.

Fig. 484.

Neckera antipyretica.
Double peristome, the inner composed of teeth united by cross bars, forming a trellis.
Magnified 100 diameters.

Fig. 485.

Polytrichum undulatum.
Creeping filaments with innovations.
Magnified 5 diameters.

and in this way, patches of moss frequently increase to a great size.

They also produce confervoid filaments, which exhibit tuberous thickenings, a form of *gemmæ* (figs. 488, 489), which may be detached from each other like bulbils, so as to propagate the plants without any sexual reproductive organs.

The protoplasm of these confervoid filaments also forms Amœboid bodies, and gonidia or ciliated zoospores (Hicks).

Gemmæ or minute cellular tubercles, capable of development into new plants, are likewise met with in other situations, as in the axils of leaves, on the surface, the margins (fig. 490), or at the tips (figs. 486, 487) of the leaves or the stems (fig. 491): these are formed of only a few cells at the time they fall off, and illustrate well the

Fig. 486.

Fig. 487.

Orthotrichum phyllanthum.
Leaves with gemmæ at the tips.
Magnified 25 diameters.

independence of the individual cells forming the organs of these plants, where, under peculiar circumstances, a single cell of the tissue may be developed so as to lay the foundation of a new plant.

In the following arrangement of the Mosses we follow Müller. The order Muscaceæ is first divided into two suborders according to the habit of growth:

ACROCARPI. Mosses with the fruit-stalk terminating the stem, or short special branches (Cladocarpi).

PLEUROCARPI. Mosses with the fruit-stalk produced only from lateral buds.

Synopsis of the Families.

ACROCARPI.

* **Schistocarpi.** *Capsule without a lid (operculum), opening by longitudinal fissures.*

ANDRÆACEÆ. Capsule splitting into four valves.

** **Cleistocarpi.** *Capsule without a lid, bursting open irregularly.*

BRUCHIACEÆ. Cells of the leaf (*areolation*) parenchymatous, looser at the base, not papillose, dense.

PHASCACEÆ. Areolation of the leaf parenchymatous, dense, filled with chlorophyll, more or less papillose.

EPHEMEREÆ. Areolation of the leaf parenchymatous, everywhere lax, not papillose.

Fig. 488.

Fig. 489.

Hedwigia ciliata.
Creeping filaments with tuber-like gemmæ.
Fig. 488, magnified 50 diameters.
Fig. 489, magnified 20 diameters.

Fig. 490.

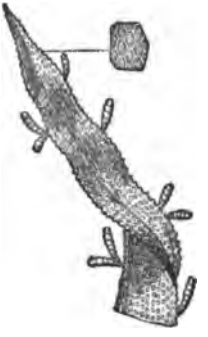


Fig. 491.

Fig. 490. Orthotrichum Lyellii. Leaves with marginal gemmæ. Magn. 50 diams.
Fig. 491. Aulacomnium undulatum. Gemmæ in the place of the capsule. Magn. 20 diams.

*** **Stegocarpi.** *Capsule bursting by a lid.*

Distichophylla. *Leaves arranged in two straight rows.*

a. Leaves regularly vertical.

SCHISTOSTEGEÆ.

b. Leaves regularly subvertical.

DREPANOPHYLLEÆ.

c. Leaves horizontal.

DISTICHIACEÆ. Areolation of the leaves parenchymatous, minute; leaves without appendicular laminæ.

FISSIDENTEÆ. Areolation of the leaves parenchymatous; leaves produced into appendicular laminæ at the back and point.

Polystichophylla. *Leaves arranged in three or more straight alternating rows.*

a. Leaves exhibiting narrow green cells, forming a reticulation between larger diaphanous cells.

LEUCOBRYACEÆ. Leaves composed of several layers of columnar, empty, parenchymatous cells; the 'intercellular' green cells three- to four-angled, interposed between the empty cells in a single curved row.

SPHAGNACEÆ. Leaves composed of a single stratum of empty prosenchymatous cells, with intercellular green cells interposed between all the empty cells. Cladocarpous, branches fasciculate.

b. Leaves without 'intercellular' cells.

a. Leaves not papillose.

1. Loosely areolated.

FUNARIOIDEÆ. Areolation of the leaf parenchymatous, lax, containing much chlorophyll.

DISCELIACEÆ. Areolation of the leaves rhomboid-prosenchymatous, destitute of chlorophyll, empty, fuscescent.

BUXBAUMIACEÆ. Areolation of the leaf hexagonal or polygonal, very minute, dark-coloured, destitute of chlorophyll.

2. Densely areolated.

MNIOIDEÆ. Areolation of the leaf in parallelograms at the base, round-hexagonally parenchymatous towards the apex; very full of chlorophyll, or more frequently thickened (very rarely papillose).

BRYACEÆ. Areolation of the leaf prosenchymatous, ordinarily rhomboidal, abounding with chlorophyll.

DICRANACEÆ. Cells of the leaf prosenchymatous, very often intermixed with parenchymatous cells (rarely scabrously papillose), alar basilar cells ordinarily crowded and ventricose, or flat and much more loosely reticulated than the upper cells.

LEPTOTRICHACEÆ. Cells of the leaf rhombic at the base, rectangular or both mixed further up, smooth, without proper alar cells.

b. Leaves papillose.

BARTRAMIOIDEÆ. Cells of the leaves parenchymatous, square, ordinarily nodulose or scabrous with papillæ at the transversal sides, never opaque.

POTTIOIDEÆ. Cells of the leaves parenchymatous, square, ordinarily covered on all sides with papillæ above the base, but smooth and pellucid at the base.

DIPHYSCIACEÆ. Leaves of two kinds; the cauline with the cells densely hexagonally parenchymatous, abounding with chlorophyll, the perichætial leaves with the cells destitute of chlorophyll and more loosely reticulated.

PLEUROCARPI.

Distichophylla. *Leaves arranged in two opposite rows.*

PHYLLOGONIACEÆ.

Tristichophylla. *Leaves arranged in three rows, appearing like three, erect, of two forms.*

HYPOPTERYGIACEÆ. Cells of the leaf everywhere prosenchymatous, equal.

Polystichophylla. *Leaves arranged in four or more rows.*

MNIADELPHACEÆ. Cells of the leaf parenchymatous, Mnioid.

HYPNOIDEÆ. Cells of the leaf prosenchymatous, rhombic or rounded.

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Sachs, *Bot.* 359; Janczewsky, *Bot. Zeit.* 1872.

MOTH, CLOTHES. See TINEA.

MOTHER CELL, or PARENT CELL, the term commonly applied to the cell in the interior of which a new generation of cells is developed.

MOTHER-OF-PEARL. See SHELL.

MOUGEO'TIA.—A genus of Zygnemaceæ (Confervoid Algæ), distinguished by the conjugation of the filaments taking place without the formation of transverse processes, the conjugating filaments being geniculately bent. There is still obscurity as to the mode of reproduction of the plants of this genus. According to Vaucher, a spore is formed in one of the conjugating cells, without transfer of contents, and this, germinating *in situ*, breaks out from the parent cell. Hassall says the plants are reproduced by zoospores; this has been confirmed by Kützing, who, together with Itzigsohn, has observed the formation of small rounded resting-spores in the joints, which underwent segmentation and developed a number of smaller cells, the ultimate fate of which was not observed. All this tends to prove that the reproduction agrees with that of *Spirogyra*, where we have:—1. large conjugation-spores, sometimes germinating *in situ*, producing in some cases new filaments, in others zoospores; 2. zoospores produced immediately from the contents; and 3. what appeared to be encysted forms of these (see SPIROGYRA).

M. genuflexa, Ag. (fig. 139, p. 205). The cells are about 1-720″ in diameter in large specimens (*M. major*, Hass.), and about three or four times as long; in smaller specimens (*M. genuflexa*, Hass., *M. gracilis*, Kütz.) the diameter is about 1-200″, the length of the cells five or six times as great.

In fig. 139 the lowest filament does not belong to the genus; but the method of conjugation of *Mougeotia* is seen in the one above.

M. lævis, Archer, is an Irish form.

BIBL. Vaucher, *Conf. d'eau douce*, 79, pl. 8; Hassall, *Alg.* 171, pl. 40; Kütz. *Sp. Alg.* 43; *Tab. Phyc.* v. pls. 1-3 and 36; Itzigsohn, *Bot. Zeit.* xi. 681, 1853; Rabenh. *Alg.* iii. 255; Archer, *Qu. Mic. Jn.* 1867.

MOULDS and MILDEWS. — These names are generally applied indifferently to a multitude of Hyphomycetous, Phycomycetous and Coniomycetous Fungi; but some of the more common ones are especially distinguished. Thus ordinary 'blue mould' of cheese, &c. is ASPERGILLUS *glaucus*; another still more common blue or green mould is PENICILLIUM *glaucum*; various species of OIDIUM and ERYSIPHE are known as the mildews of the Hop, Vine, Rose, &c. The mildew of wheat is PUCCINIA *graminis*.

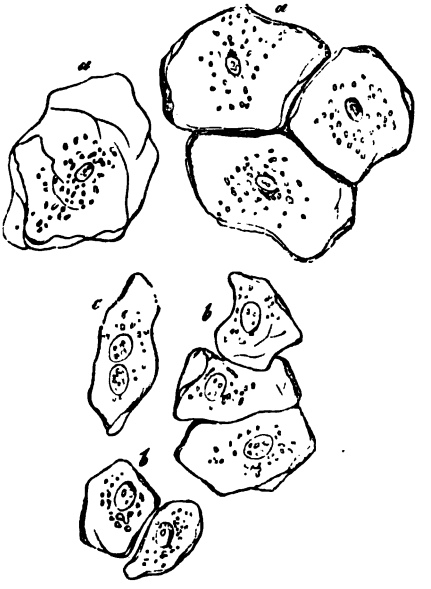
MOUNTING. See PRESERVATION.

MOUSE, HAIR OF (Pl. 1. fig. 3; Pl. 29. figs. 27, 28). See HAIR OF ANIMALS and TEST-OBJECTS.

MOUTH. — The mucous membrane of the mouth, which becomes continuous with the skin at the lips, is furnished with very numerous conical or filamentous papillæ resembling those of the skin, sometimes simple, at others branched, and a number of mucous glands.

Its epithelium is of the pavement kind, consisting of several layers of delicate cells; these are roundish in the deeper, flattened and polygonal in the superficial layers.

Fig. 492.



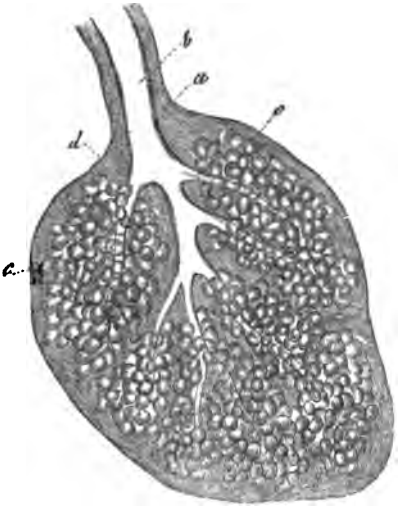
Epithelial cells of the mucous membrane of the human mouth: *a*, large, *b*, smaller cells; *c*, one with two nuclei.

Magnified 350 diameters.

The glands, distinguished, according to their situation, as the labial, the buccal, and the palatal glands, are rounded, about 1-36

to 1-6″ in size, and open by short excretory ducts into the mouth. They consist of glandular lobules enveloped in areolar tissue with elastic fibres, the whole being surrounded by a firmer portion or capsule, and a branched duct. The lobules are composed of a number of convoluted canals or lobular

Fig. 493.



Human racemose mucous gland from the floor of the cavity of the mouth. *a*, areolar coat; *b*, excretory duct; *c*, glandular cæca; *d*, lobular ducts.

Magnified 50 diameters.

ducts, with simple or compound cæca or glandular vesicles, each consisting of a

Fig. 494.

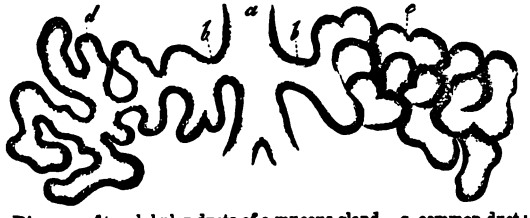


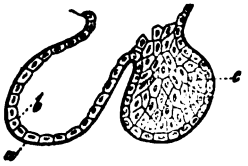
Diagram of two lobular ducts of a mucous gland. *a*, common duct; *b*, lobular branch; *c*, glandular vesicles *in situ*; *d*, the same separated, and the ducts unfolded.

Magnified 100 diameters.

basement membrane and a single layer of angular epithelial cells. The latter separate very readily; and then the cæca appear filled with a granular mass.

The ducts of the lobules have a coat of connective tissue, with networks of fine elastic fibres, and a single layer of cylindrical epithelial cells.

Fig. 495.



Two glandular vesicles of a human racemose mucous gland. *a*, basement-membrane; *b*, epithelium, side view; *c*, the same in surface view.

Magnified 100 diameters.

The mucous liquid of the mouth contains, in addition to detached epithelial cells, very transparent corpuscles, about 1-2000 to 1-1500″ in diameter, consisting of a delicate cell-wall, a nucleus, with a number of minute moving molecules. We have figured these among the TEST-OBJECTS (Pl. 1. fig. 5). They are called mucous or salivary corpuscles. Kölliker regards them as a form of exudation corpuscles: and this view is probably correct; for they may occur in the secretion of any mucous surface, and have no special connexion with the salivary glands: we have found them in myriads in the urine.

The secretion of the mouth frequently contains very slender filaments of a fungus (LEPTOTHRIX), with species of *Monas* and of *Vibrio*.

BIBL. Kölliker, *Mik. An.* ii.; Sebastian, *Rech. An. s. l. gland. labial.*; Webb, *Qu. Jn. Med. Sci.* 1857; Ward, *Todd's Cycl. An.&c.*; Klein *in Stricker, Hist.* i.

MUCED'INES.—A family of Hyphomycetous Fungi, forming moulds and mildews upon living or decaying animal or vegetable substances, and contributing to their decomposition, characterized by a flocculent mycelium bearing erect, continuous or septate, simple or branched, tubular pellucid filaments, terminating in single spores or strings of spores, which soon separate from each other, and lie among the filaments of the mycelium. This tribe includes a number of the most

interesting of the microscopic fungi, noted for their destructive influence upon organic bodies which they attack. The species of *Botrytis*, *Oidium*, &c. spread with wonderful rapidity as mildews over the herbaceous parts of vegetables and moist vegetable substances generally; in the former situations their spores enter the stomata, their mycelia ramifying among the subjacent cells, and carrying decomposition and decay into all the soft structures. They are most abundantly developed in a close, damp atmosphere. The mycelia of other kinds, as of PENICILLIUM, growing in liquids containing organic matter, or upon decaying vegetable substances, produce remarkable chemical decompositions, causing a fermentation of the medium in which they exist.

See PENICILLIUM and FERMENTATION.

Synopsis of British and nearly allied Genera.

A. Fertile filaments (*pedicels*) simple or branched, terminating in single spores or a very short row.

* *Spores simple.*

Botrytis. Pedicels erect, septate, branched; branches and branchlets septate; spores solitary, on the tips of the branchlets, which are either racemose, umbellate, cymose (*Polyactis*), paniculate, verticillate (*Acrostalagmus*), spicate (*Haplaria*) or capitate.

Peronospora. Like *Botrytis*, but the pedicels without septa; often producing resting-spores.

Verticillium. Pedicels erect, septate, with whorled branches terminating in a solitary spore or a short row of spores.

Acremonium. Pedicels short, subulate, branches from a horizontal filament, bearing single smooth spores.

Zygodesmus. Like the last, but with echinulate spores.

Oidium. Pedicels simple, short, erect, clavate, septate, bearing usually one, sometimes two more or less oval spores.

Fusidium. Pedicels very short, pulvinate. Spores elongate, fusiform.

Menispora. Pedicels erect, septate, bearing fusiform or cylindrical spores, at first joined in bundles.

Sceptromyces. Pedicels erect, geniculate, verticillately branched; branches short, racemose; spores in grape-like bunches.

** *Spores septate.*

Brachycladium. Pedicels branched above, septate, moniliform; branches and branchlets forming a sporiferous capitulum; spores transversely septate.

Trichothecium. Pedicels interwoven in tufts, the central erect, fertile; spores acrogenous, didymous, free, commonly loosely heaped together.

Cephalothecium. Pedicels simple, continuous, bearing a terminal head of didymous spores.

B. Erect filaments (*pedicels*) terminating in strings of spores.

* *Spores simple.*

Penicillium. Pedicels erect, septate, penicillately branched above; branches and branchlets septate; strings of spores attached to the tips of the branches.

Sporotrichum. Pedicels erect, simple or slightly branched, septate and articulate, articulations remote, inflated; spores simple, usually found collected in heaps among the filaments.

Briarea. Pedicels erect, septate, with terminal moniliform chains of spores, crowded into a head.

Gonatorrhodon. Pedicels erect, septate, with chains of spores in a terminal head and in whorls at the joints.

** *Spores septate.*

Dendryphium. Pedicels erect, septate, unbranched; strings of spores attached in a bunch to the apex; spores septate.

Dactylium. Pedicels erect, septate, branched above; strings of septate spores attached singly or in pairs to the apices of the branches.

C. Fertile filaments (*pedicels*) inflated at the tips or at various points in their length, with projecting points or warts on the inflations, bearing

* *Simple spores.*

Aspergillus. Pedicels continuous, erect, simple filaments, inflated into a little head at the summit, bearing moniliform chains of spores, crowded into a capitulum.

Rhinotrichum. Pedicels erect, septate, sometimes sparingly branched, the apices clavate, cellular, bearing scattered points supporting simple spores.

Papulaspora. Pedicels, short lateral branches from a creeping filament, terminating in cellular heads beset with simple spores on the areolæ.

Rhopalomyces. Pedicels erect, not septate, terminating in cellular heads, with simple spores on the areolæ.

Stachylidium. Pedicels erect, articulated, whorled-branched above; branchlets geniculate and articulate; spores subpedicellate, accumulated in little capituliform heads inserted at the tips of the branches.

Gonatobotrys. Pedicels erect, septate, with joints swollen at intervals, the swollen joints bearing globular heaps of spores on short spines spirally arranged.

Acmosporium. Pedicels erect, septate, branched above; branches and branchlets forming a cyme, thickened at the apex, and furnished with globular capitules covered all over with points; spores simple, attached on the points of the capitules.

Haplotrichum. Pedicels erect, septate, terminating above in a continuous, simple, solitary, sporiferous head; spores simple.

Actinocladium. Pedicels erect, septate, umbellately branched at the summit; spores simple, accumulated at the tips of the branches.

Botryosporium. Pedicels erect, septate, with short spine-like branchlets above, spirally arranged, and terminating in four or five short points, which support globular heads of spores.

** *Spores septate.*

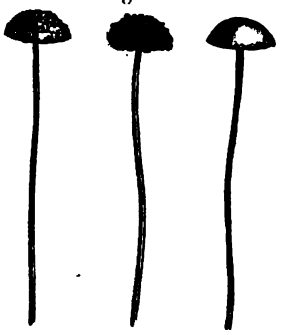
Arthrobotrys. Pedicels simple, septate, with joints swollen at intervals, the swollen joints clothed with spines bearing didymous spores, which are collected into globular heaps.

Some of the species are mere conditions of perfect Fungi, as *Hypoxylon* and *Claviceps*. In several genera, sexual union like that in *Tuber* and *Peziza* takes place.

MU'COR, Micheli.—A genus of Mucorini (Phycomycetous Fungi), forming a common mould on paste, decaying fruits, or other vegetable matters. The general character is that of an interwoven mass of horizontal branched filaments, sending down little root-like ramules, and pushing up erect, not septate, fertile filaments, which branch at the base in a stoloniferous manner, and thus form loosely grouped tufts. At the summit of the erect filaments, a globular vesicle is formed, which soon becomes cut off by a septum. Its contents become divided into a large number of spores; and the septum at the base becomes meanwhile pushed up or protruded into the centre of the vesicle so as to form a kind of "core," called the *columella*. After a time the vesicle (*peridiole*) bursts and discharges its spores; the pressure of the turgid columella apparently hastens the bursting. The dehiscence takes place either by a circular slit just above the base of the columella, leaving this alone, surrounded by a narrow ragged collar (*Mucor*), or the peridiole bursts above and disappears by solution, and the columella collapses upon the pedicel (*Ascophora*, fig. 497). The membrane of the peridiole of *M. Mucedo*, and perhaps of other species, is clothed with minute spines. The erect filament is sometimes simple, sometimes branched. It has been conjectured, though on what grounds is uncertain, that the columella may become converted into a second peridiole, by being shut off by a septum which is converted into a new columella.

Fig. 496.

Fig. 497.



Mucor Mucedo.
(*Ascophora* form.)

Fig. 496. Nat. size, growing on a leaf.
Fig. 497. Single fertile filaments, with the columella collapsed, and fallen like a cap over the end. Magn. 50 diams.

It has been imagined that ACHLYA is only an aquatic form of *Mucor*; and this seems not improbable; however, the expe-

riments we have made on this point have hitherto given negative results.

The species of *Mucor* described by authors are pretty numerous; but we think considerable allowance for variation should always be made in this genus. RHIZOPUS, Ehr. = *Mucor* when distinctly stoloniferous. It seems very doubtful whether HYDROPHORA should be separated from *Mucor*. Conjugation takes place in one or two species.

* *Fertile filaments simple.*

M. Mucedo, L. (figs. 496, 497). Mycelium byssoid, peridiole and spores globose, at first white, ultimately blackish. (This includes *Ascophora Mucedo*, Tode.) Extremely common. Sowerby, *Fungi*, pl. 378. fig. 6; Greville (*Ascophora*), *Crypt. Fl.* pl. 269.

M. caninus, Pers. Mycelium byssoid, peridiole globose, ultimately yellow or ferruginous; spores globose or elliptic. Very common on excrement of dogs and cats in wet weather. Grev. *Sc. Crypt. Fl.* pl. 305.

M. fusiger, Lk. Mycelium byssoid. Peridiole globose, ultimately black; spores spindle-shaped. On decaying fungi.

M. clavatus, Lk. Mycelium byssoid. Clavate apices of the fertile filaments simply penetrating the globose peridiole; spores globose, at first white, then brown, at length black. On rotten pears; possibly only a state of *M. Mucedo* or the following.

M. amethysteus. Mycelium thick, white, closely interwoven. Peridiole at first white, then pale yellow, then crystalline and pure violet, finally violet-black or brownish; spores globose, filled with globose sporidioles (?). Fertile filament 1-40″ high. On rotten pears with the foregoing.

M. delicatulus, Berk. Mycelium forming a thin velvety stratum. Very minute; fertile filaments short; peridioles globose, pale yellow; spores globose. On rotting gourds.

M. succosus, Berk. Mycelium forming small, pulvinate, yellow, spongy masses. Peridiole very minute, globose, yellow, at length olive; columella minute. On dead shoots of *Aucuba*. Berk. *Ann. N. H.* vi. pl. 12. fig. 15.

** *Fertile filaments branched.*

M. ramosus, Bull. Mycelium woolly. Fertile filaments racemose. Peridioles globose, yellow, then bluish-grey or reddish-brown. On rotting fungi. Bulliard, pl. 480. fig. 3.

M. subtilissimus, Berk. Mycelium creeping, filaments exceedingly slender. Fertile filaments branched, the short patent branches each terminating in a globose peridiole; spores oblong, elliptical. A mildew of onions. Berk. *Hort. Jn.* iii. 97. figs. 1-5.

BIBL. Berk. *Br. Flora*, ii. pt. 2. 332; *Ann. N. H.* vi. 433; *Hort. Jn.* iii. 91; Fries, *Summa Veg.* 487; *Syst. Myc.* iii. 318; Fresenius, *Beitr. z. Mycologie*, heft i. 4, 1850; v. Tieghem, *Ann. Sc. N.* 1875, i. 5; Brefeld, *Flora*, 1873.

MUCORINI.—A family of microscopic Phycomycetous Fungi, constituting the moulds, &c. common on most decaying vegetable and animal substances, consisting of a filamentous mycelium, forming flocks and clouds in or on decaying matters, bearing vesicles, on erect pedicels or sessile, filled with minute sporules, discharged by the rupture of the vesicles (*peridioles*). These plants correspond among the thecasporous Fungi to the Mucedines among the acrosporous or free-spored orders. The peridiole consists of the terminal cell of an erect filament, enlarged like the head on a pin, into a globular vesicle. At first the cavity of this vesicle communicates with that of the pedicel; but a septum is soon formed; in some genera this septum is flat, in others projecting into the interior of the peridiole like the "punt" of a bottle, forming a hemispherical or cylindrical columella. While this columella rises in the peridiole, the latter becomes filled with spores, forming thus a polysporous sporange; and it bursts to let them escape.

The manner of bursting of the sporange and the form of the central column vary much, and afford generic characters. *Thelactis* presents a remarkable peculiarity: each filament terminates in a sporange containing a great number of spores, while at its base it gives origin to whorls of branches, the terminal cells of which remain sterile.

Syzygites exhibits conjugation of its branches, like that of the Zygnemaceæ.

Some observations of De Bary tend to show that the genus *Eurotium* only represents certain conditions of *Aspergillus*. In some cases the lower threads are enormously developed, where, from excessive moisture, the fruit cannot be produced. Two different forms of fruit occasionally occur in the same thread, as in *Ascophora elegans*.

Synopsis of British Genera.

Phycomyces. Peridiole pear-shaped, separated from the apex of the erect pedicel

by an even joint; opening by an umbilicus. Spores oblong, very large. Filaments cæspitose, tubular, continuous, and shining.

Hydrophora. Peridiole subglobose, membranous, dehiscent, at first crystalline, aqueous, then turbid, and at length indurated, persistent. Columella absent; spores simple, conglobated.

Mucor. Peridiole subglobose, separating like a cap (leaving an annular fragment attached) from the erect, simple, continuous pedicel, or bursting irregularly; columella cylindrical or ovate, spores simple.

(?) *Acrostalagmus.* Peridioles globose, with a columella, at the points of doubly verticillate branches from an erect pedicel.

Pilobolus. Peridiole globular, separating like a cap from the short stalk composed of a single cell, attached on a unicellular ramified mycelium; columella conical; spores very numerous, free in the peridiole.

Syzygites. Filaments erect, simple, very much branched above, branches and branchlets di- or trichotomous, fertile branches forcipate, bearing pairs of opposite internal clavate branches, which subsequently coalesce.

MUCOUS CORPUSCLES. See MOUTH.

MUCOUS MEMBRANES.—Those internal canals and cavities of the body which open externally, as the alimentary canal, bladder, &c., are bounded by what may be regarded as internal prolongations of the skin, called mucous membranes.

They consist of four layers:—1, an innermost or epithelial layer, corresponding to the cutaneous epidermis; 2, a subjacent structureless basement membrane, which is not always separable and demonstrable or present; 3, a layer of variable thickness, consisting of connective and elastic tissue, well supplied with blood-vessels and nerves, often containing numerous small glands, frequently furnished with conical or filiform processes termed papillæ or villi, and sometimes traversed by muscular fibres. These three layers form the proper mucous membrane; and are supported by, 4, an outermost submucous layer or coat, composed of the same elements as the last, but much more lax in structure, and frequently containing fatty tissue.

The mucous membranes are usually very vascular; and injected preparations of them are very beautiful, and to some extent characteristic.

The size and form of the epithelial cells are to a certain extent also characteristic, especially those of the uppermost layer; and a knowledge of the peculiar structure in individual cases is of use in determining the source of morbid mucous products mixed with epithelial cells.

See the special articles.

MUCRONEL'LA, Hincks, = *Lepralia* pt. Zoary incrusting; cells with a rounded or semicircular orifice, and an anterior tooth. Several species; on rocks, shells, and seaweeds. (Hincks, *Polyz.* 360.)

MUCUS.—Natural mucus contains no essential morphological elements. As ordinarily met with, it often, however, exhibits some epithelial cells, mucous corpuscles, and numerous granules; and the peculiar mucous matter has a striated or fibrous appearance, mostly produced artificially. The abnormal elements are principally those of inflammation.

BIBL. See CHEMISTRY, ANIMAL.

MUD.—The organisms found in mud are very numerous; they consist principally of Diatomaceæ and other minute Algæ. The surface of mud is often covered with yellowish or greenish layers, composed almost entirely of these organisms. The most beautiful and most numerous forms of Diatomaceæ are found in the mud of sea-water, or that of tidal rivers. On exposing a bottle of mud and water to the light, they will rise to the surface of the mud, some adhering to the side of the bottle next the light, and can then be easily separated. The surface of freshwater-mud frequently appears of a blood-red colour, from the presence of *Tubifex rivulorum.*

MUREX'IDE. See AMMONIA, PURPURATE OF.

MURIATE OF AMMONIA. See AMMONIA, HYDROCHLORATE OF.

MU'RIFORM.—The term applied to flattened six-sided cells placed one above the other in one or more rows, like bricks in a wall.

MU'SA, Tournef.—A genus of Musaceæ (Monocotyledonous Flowering Plants), comprising the Bananas and Plantains. The fibro-vascular bundles of *Musa* afford examples of spiral vessels with numerous spiral fibres (see SPIRAL STRUCTURES). *Musa textilis* affords the fibre called Manilla hemp (see Pl. 28. fig. 7). See FIBROUS STRUCTURES.

MUS'CA, Linn.—A genus of Dipterous Insects, of the family Muscidæ.

Among the well-known species, all of

which have been formed into new *genera*, we may mention:

Musca domestica, L., common house-fly. Third joint of antennæ thrice the length of the second; style plumose, eyes reddish brown, front of head white, the rest black; thorax blackish grey with four longitudinal black bands, abdomen blackish brown above, with blackish elongated spots, pale yellowish brown beneath.

M. carnaria, L. (*Sarcophaga*, Meigen), the flesh-fly. Antennæ feathery; head golden-yellow in front, eyes reddish; thorax grey, with black longitudinal lines; abdomen black, with four square white spots on each segment; all the body strewed with black hairs. Viviparous, 1-2″ long.

M. Cæsar, L. (*Lucilia*, Donov.). No spots, abdomen green, with a metallic lustre.

M. vomitoria, L. (*Calliphora*, Donov.), bluebottle or blow-fly. Head yellowish, golden or white, eyes brown; thorax black; abdomen shining blue with black stripes and long black hairs.

The larvæ are known as gentles. The ova or larvæ are deposited upon animal or vegetable substances, mostly in a state of decay, upon which they live.

Several parts of the species of *Musca* are of general microscopic interest,—as the proboscis (Pl. 33. fig. 29) with its two fleshy lobes (*c*), kept expanded by a beautiful and elastic framework of modified tracheæ; the setæ or lancets (*b*), which are modified maxillæ, sometimes rudimentary, with their palpi (*a*) at the base; the remarkable antennæ (Pl. 33. fig. 20); the elegant tarsus (Pl. 34. fig. 7 *a*), with its terminal spine, pulvilli (figs. 7, 8 & 9) and claws; and the rudimentary wings or halteres (INSECTS, p. 432).

Musca pumilionis (*Chlorops*, Meig.) deposits its eggs in the young wheat-grain, which is consumed and destroyed by the larvæ.

Many other members of allied families of Diptera, commonly known also as flies, are of microscopic interest, on account of their oral setæ or lancet-like organs.

BIBL. Westwood, *Intr.*; Macquart, *Ins. Dipt.*; Meigen, *Syst. zweifliig. Insect.*; Keller, *Stubenfliege*; Suffolk, *Mn. Mic. Jn.* i. 331; Lowne, *on the Blow-fly*.

MUSCA'CEÆ. See MOSSES.

MUSCARDINE. — A disease in silkworms, in which the whole of the sebaceous matter is exhausted, and the blood greatly altered, by a species of mould, *Botrytis bassiana*, which is perhaps too near *Botrytis diffusa*, Grev. A few of the spores placed on the back of a healthy silkworm are sufficient to impregnate the whole body. It takes its name from the resemblance of the diseased caterpillar to a peculiar kind of pastile.

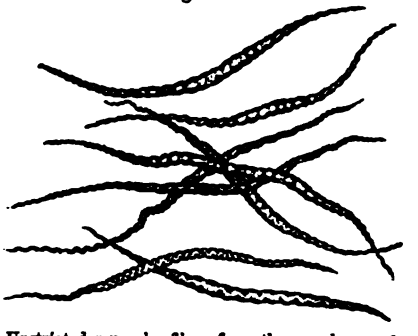
BIBL. Balsamo, *Gaz. de Milan*, 1835; *Bibl. It.* xxix. 1835; Robin, *Vég. Par.* 560; Guérin, *Séric.* 1849, 1850, 1851.

MUSCLE.—Muscular tissue forms the greater portion of the flesh of animals.

It occurs in two principal forms; one of which is termed organic, unstriated, or unstriped muscle; the other, voluntary, striated, or striped muscle.

Unstriated muscle.—This consists of more or less elongated, somewhat spindle-shaped, narrow fibres (p. 74, fig. 35), having the import of cells, and hence often called fibre-cells; they are, however, solid. Each contains an elongated nucleus, brought to light by acetic acid, and exhibiting a reticular appearance. The fibres are of variable length (from about 1-580 to 1-250″), and 1-5000 to 1-3500″ in diameter. They often appear longitudinally fibrous within; and the cell-wall is transversely wrinkled. They sometimes exist singly in the midst of connective tissue; at others they are united into rounded or flattened bundles, and surrounded by an imperfect kind of sarcolemma, composed of connective tissue with elastic fibres.

Fig. 498.



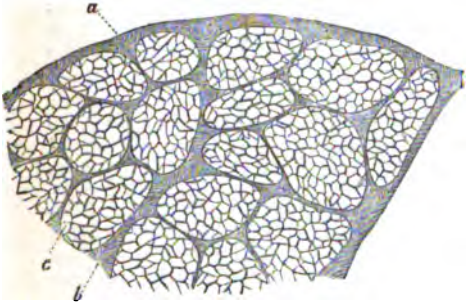
Unstriated muscular fibres from the œsophagus of a pig, after treatment with dilute nitric acid.
Magnified 10 diameters.

They occur most abundantly in the hollow viscera, as the stomach, the intestines, the bladder, and the uterus; but they also exist in other situations, as the spleen,

trachea and bronchi, the dartos, the arteries, veins, and lymphatics, the prostate gland, fallopian tubes, urethra, villi of the small intestines, the skin, iris, and beneath the lung-pleura, &c.

Striated muscle.—The structure of striated is more complex than that of unstriated muscular tissue. It consists of a number of very slender fibres, called fibrillæ, connected into bundles, termed primitive bundles or fasciculi, each of which is enclosed in a sheath or sarcolemma. The primitive bundles are again united into secondary and tertiary bundles, the whole being bound together by a mass of connective and elastic tissue surrounding each of them, and forming the perimysium. This arrangement is best seen in a transverse section (fig. 499).

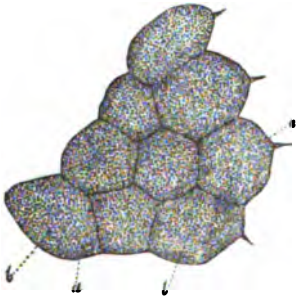
Fig. 499.



Transverse section of a portion of the sterno-cleidomastoideus: *a*, outer perimysium; *b*, inner perimysium; *c*, primitive and secondary muscular bundles.

Magnified 50 diameters.

Fig. 500.

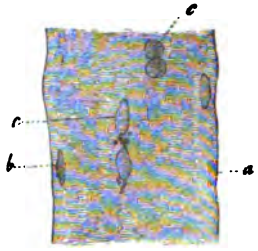


Transverse section of the muscular fibres or primitive bundles of the human gastrocnemius: *a*, sarcolemma and interstitial connective tissue; *b*, section of fibrillæ and intermediate substance.

Magnified 350 diameters.

The primitive bundles are from about 1-1000 te 1-200″ in diameter, and of a rounded or polygonal form (fig. 500). Their surfaces are marked by a number of transverse striæ, which forms the most characteristic appearance of the tissue. They also exhibit irregular longitudinal striæ, which are the indications of the component fibrillæ (Pl. 22. fig. 35).

Fig. 501.



Portion of a primitive bundle treated with acetic acid: *a*, sarcolemma; *b*, single nucleus; *c*, twin nuclei surrounded by granules of fat.

Magnified 450 diameters.

The sheath or sarcolemma, when separated from the muscular substance by treatment with water, acetic acid, and alkalies, in which it is insoluble, forms a structureless, transparent and smooth membrane. It is perhaps most easily seen in the muscle of fishes by simple dissection (Pl. 50. fig. 18). On its inner side are numerous spindle-shaped or lenticular nuclei (fig. 501).

The ultimate or primitive fibrillæ in man are about 1-20,000″ in diameter, and each exhibits numerous regularly alternating light and dark portions (Pl. 22. fig. 36 *b*); the relative positions of the two may, however, be made to change by altering the focus; but the dark bands are more highly refractive than the white. The ends of the fibrillæ are distinguishable in transverse sections of the primitive bundles; and their lateral margins are perfectly straight.

Different views have been taken of the structure of the fibrillæ, and, in fact, of the general structure of muscle. Thus the ultimate fibrillæ have been described as moniliform or beaded (Pl. 22. fig. 36 *c*); this appearance, however, arises from an optical illusion, connected either with imperfection in the object-glasses used, viewing the object in too much liquid, or the use of too low an object-glass, and too high an eye-piece.

It often happens, especially when muscle has been kept in spirit, that it separates transversely into a number of flat disks (fig. 502); hence it has been viewed as consisting of these disks. Again, as under certain conditions it separates longitudinally into fibrillæ and transversely into disks, it has been supposed to consist of primitive particles or 'sarcous elements' united end to end as well as laterally. We admit the existence of the primitive fibrillæ as original components of muscle, though there can be little doubt that the fibrillæ are not homogeneous, and of uniform constitution either chemical or physical. On carefully examining them at different foci, it is seen that those portions of isolated fibrils which appear dark when the margins of the fibrils are best in focus, are more highly refractive than the intermediate portions, as shown by the greater luminosity they acquire on altering the focus of the object-glass; and that this focal effect does not arise from a lenticular form of the parts is evident from the straight condition of the margins of the fibrils. Hence these more highly refractive parts probably constitute the proper muscular substance, connected in the direction of their length by a different kind of substance, which becomes brittle under the action of spirit, whilst the former does not; for the line of separation into the disks occurs through the less highly refractive portions. And that these compound fibrils naturally exist, is shown by their being distinguishable in a primitive bundle without the use of reagents, or even of mechanical means.

Fig. 502.

A, a primitive bundle, magnified 350 diameters, partly separated into disks, side view. *B*, the same, rather more magnified, end view.

It has always been supposed that the ultimate fibrils are composed of cells arranged end to end; and the appearance represented in Pl. 22. fig. 36 *a*, which is sometimes met with, might countenance this notion. But whenever it is seen, there is imperfect definition, from the presence of too much liquid, or some other cause; for we have never observed it when the object was properly arranged and examined.

On examining the fibrillæ under a very high power, each white band is seen to be divided by a faint dark line, Krause's line or membrane, which is regarded as a transverse partition, the compartments being occupied by the true muscular substance; and it is through this line, that the fibrils separate into the disks (Pl. 22. fig. 36 *d*); or, often the same part appears bounded at each end by a transverse dark line (fig. 36 *b*), or both parts are traversed mesially by a transverse dark line. In some instances we have noticed a very delicate constriction, which would account for these appearances; but the explanation of this we have failed to discover.

The dark portions of the various fibrillæ of the primitive bundles being opposite to each other, gives rise to the coarser dark striæ seen under a low power. But it often happens that by pressure or manipulation this natural relation is destroyed, the direction of the striæ is altered, and sometimes those of one bundle are made to alternate with those of the next. Hence arises an appearance of transverse or spiral fibres (Pl. 22. fig. 35); but none such really exist in muscle.

Muscle consists chemically of a proteine compound called syntonine, resembling fibrine in many of its properties. By pressing muscles a liquid is obtained, containing some peculiar organic substances.

The unstriated and the striated muscular fibres have the same chemical composition.

In regard to the development of muscle, it appears that muscular fibre proceeds from cells which elongate, each becoming fusiform, and at the same time increasing enormously in thickness; the nucleus also increases, and the cell-contents become striated to form the muscle.

The muscles are very vascular. The smaller branches of the vessels mostly run parallel to the primitive bundles in the perimysium, and anastomose by transverse or oblique branches.

The bundles of transversely striated muscular fibres in many of the lower animals, and in the heart of man, are found to branch and form networks. This may be well observed in the muscles of the tongue of the frog.

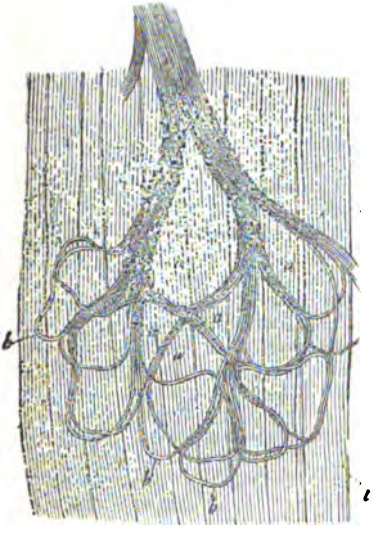
Schäfer points out that the dark bands of the muscular fibrils of certain insects, as *Dytiscus marginalis*, are traversed by nume-

rous very slender parallel longitudinal *muscle-rods* (Pl. 22. fig. 36 *e*). These extend at either end into the adjacent white bands, terminating in knotted ends; forming a row, running transversely across each white band.

When muscular fibres are examined by polarized light, the sarcous elements are seen to be anisotropous or doubly refractive, while the intermediate substance is isotropous.

They are also well supplied with nerves; these mostly (always, Beale) terminate in a plexus of looped branches (fig. 503).

Fig. 503.



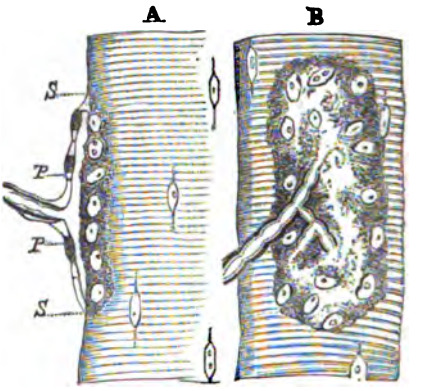
Termination of the branches of a nerve in a portion of the omohyoideus muscle, treated with caustic soda: *a*, meshes of the terminal plexus; *b*, loops; *c*, muscular fibres.

Magnified 350 diameters.

In the Insects and Reptiles the nerves terminate in granular nucleated swellings, spread over the muscular bundles; their sheaths becoming continuous with the sarcolemma, the nerve-fibres branching off in various directions.

Muscle undergoes important changes in disease. Wounds are filled up with connective or tendinous tissue. In atrophy and fatty degeneration, the bundles become smaller, softer, more readily broken up, the transverse striæ and fibrillæ indistinct, or apparently absent, and contain yellowish or brown pigment-granules, with more or less numerous globules of fat (Pl. 38. fig. 14 *a*), and sometimes a large number of nuclei or small cells.

Fig. 503*.



Muscular fibres with nerve-ends from *Lacerta viridis*. A. Seen in profile: *P P*, the terminal nerve expansion or plate; *S S*, its support or base, consisting of a granular mass with nuclei. B. The same, seen in a perfectly fresh muscular fibre.

The interfascicular connective tissue is also sometimes increased in amount, and fatty tissues developed in it; or the muscular substance is partially absorbed, and the sarcolemma contracting gives the bundles a moniliform appearance (Pl. 38. fig. 14 *b*). In tetanus, the fibres become varicose and often ruptured, and the striæ closer.

The muscular tissue of the lower Vertebrata and some of the Invertebrata agrees essentially in structure with that of man; but the sarcolemma is often much thicker, the fibrillæ larger, and the nuclei contained within the substance of the bundles, and sometimes arranged in regular linear series. The margins of the bundles are also sometimes uneven, and rounded at regular intervals (Pl. 22. fig. 35), giving the appearance of their being surrounded by fibres.

In many of the lower members of the Invertebrata, although the substance of the body is voluntarily contractile, no trace of fibres or bundles can be detected.

The so-called muscle-corpuscles are placed in the interior of the fibre in the muscles of the heart; and they are to be met with in Amphibia, Fishes, and Birds in the same position.

To obtain the separate fibrillæ of striated muscle, the tissue should be macerated for about two hours in alcohol. This removes fatty matter, and renders the fibrillæ more easily separable by dissection with mounted needles. The fibrillæ are very minute; hence a very small portion of the tissue only should be taken for examination. That of fishes, the cod or the skate, or of reptiles, the frog, is the best for the purpose. Or, the bottom of a glass vessel is covered with chlorate of potash, slightly moistened with water, and four parts of nitric acid added. The whole is shaken, and a portion of muscle buried beneath the crystals with a glass rod. In half an hour, the muscle is removed and placed in water, and strongly shaken, when it separates into the fibrillæ (Kühne).

The unstriated muscular fibres are best seen in muscle which has been treated with dilute nitric or muriatic acid (1 part acid to 4 water). This renders them more opaque, and often curiously tortuous or spiral (fig. 498).

Bibl. Bowman, *Todd's Cycl.* art. *Muscle*, and *Phil. Tr.* 1840–41; Lebert, *Ann. Sc. Nat.* 3 sér. xiii.; Krause, *Arch. An. u. Phys.* h. v. 646, 1868; Moxon, *Qu. Mic. Jn.* 1866, 235; Doyère, *Ann. Sci. Nat.* sér. 2. 1840; Kuhne, Brücke, Arnold, and Stricker, *Stricker's Hist.* vol. i. 1870; Quain's *An.*; Brücke, *Bau d. Muskel*, *Wiener Denkschr.* xv. 79; Heppner, *Schultze's Archiv*, v. 1869; Schäfer, *Phil. Tr.* v. 163, 429, 1873; Beale, *How &c.* 1880; Nasse, *Quergestr. Musk.* 1882; Frey, *Hist.* 301.

MUSHROOMS. See Agaricus.

MUSSEL. — The species of Mollusca commonly known as mussels are of interest to the microscopist, on account of their alimentary canal containing Diatomaceæ; the same applies also to other marine and freshwater Mollusca, as well as other animals living upon these minute Algæ.

If it be required to obtain the valves only, the entire animal may be dissolved in hot nitric acid, and the residue washed as usual in preparing the Diatomaceæ.

The gills of the common marine mussel, *Mytilus edulis*, are well adapted for the examination of the cilia and ciliary motion.

Mussels also frequently contain the nurses and larvæ (*Cercariæ*) of *Distoma* and other Trematoda.

One of the Acarina, *Hydrachna concharum*, is found in the pallial cavity or beneath the outer lamella of the branchial plates of the Naiadeæ (*Unio*, &c.).

Bibl. Dickie, *Ann. N. H.* 1848, i. 322; Vogt, *Ann. Sc. Nat.* 3 sér. xii.

MUSTARD.—The best mustard consists of the ground seeds of *Sinapis nigra* (Cruciferæ); but those of *S. alba* are largely employed. The structure of these grains is very different from those of the substances most commonly employed for adulteration,—for example, wheat-flour, which is known by its starch-granules. Inferior samples contain variable quantities of the husk of the seed, which may be detected by the microscope. Mustard is generally coloured artificially, especially when adulterated with white meals, by means of Turmeric, the peculiar colour-cells of which are readily recognizable. See Pl. 2. fig. 11; and Hassall, *Food and Adulteration*, 123.

MYCE'LIUM.—The vegetative part of the Fungi as distinguished from the fruit. Many fungi in a barren state have been described as genera, *Himantia*, *Ozonium*, *Xylostroma*. Mushroom-spawn is simply the mycelioid state of *Agaricus campestris*. The mycelium sometimes penetrates deeply into wood, rendering it of various colours, as green by *Peziza æruginosa*, red by *Corticium sanguineum*, yellow by *Hypoxylon luteum*.

Bibl. Berk. *Outl.* 39; *Crypt. Bot.* 262.

MYCETOZO'A. See Myxomycetes.

MYCOIDEA.—A genus of doubtful affinity, allied to *Chroolepus*; propagated by zoospores, also by sexual union, like *Pythium* and some other Saprolegniæ. 1 sp.; on the leaves of *Camellia*, in India (*Linn. Tr.* 2nd s. i. 301, figs.).

MYCOP'ORUM, Flot. — A genus of Lichenaceous Lichens. 3 sp., rare (Leighton, *Lich. Flo.* 437).

MYELOPLAX'ES. See Bone, p. 111.

MYLIT'TA, Fr.—A genus apparently of Tuberacei (Ascomycetous Fungi).

Mylitta australis, the native bread of the Australians, has not been found with perfect fruit; but the structure is apparently that of Tuberacei. The other species are doubtful, and perhaps mere root-tubercules.

Bibl. Cd. *Ic.*; Berk. *Ann. N. H.* 1839, 326.

MYOBIA, Heyd. See Acarus, p. 5.

MYOCOP'TES, Clap.—A genus of Acarina. *M. musculinus*, on the body of the mouse (Claparède, *Zeit. wiss. Zool.* 18; Murray, *Ec. Ent.* 325; Mégnin, 156).

MYO'MATA and MYXO'MATA. See Tumors.

MYRIAN'GIUM, Mont. and Berk.—A genus of Myriangiacei (Lichens). *M. Duriæi* on ash and elm, rare. (Leighton, *Lich. Fl.* 37).

MYRIAP'ODA.—A class of Arthropoda.

Char. Wings none; one pair of antennæ; legs numerous; thorax not separated from the abdomen.

These animals are commonly known as centipedes, millipedes, or hundred-legs.

Body usually long, cylindrical or flattened, and consisting of numerous rings, joints, or somites. Head distinct, and the jointed legs, with a single claw, arranged on each side of the body throughout its length. A few of them are broad, short, and flattened,

Fig. 504.

Iulus terrestris. Magnified 4 diameters.

somewhat resembling wood-lice. Behind the antennæ are laterally placed the eyes, which in some are absent; they usually consist of a group of ocelli.

The structure of the trophi varies in the different genera. The labrum is small, and usually consolidated with the cephalic plate. The mandibles (Pl. 35. figs. 25, 26 *b*) are often large and powerful, somewhat resembling those of the spiders, and, like them, traversed by a canal, through which the duct of a poison-gland passes. The maxillæ are smaller, softer, and furnished with two palpi. The labium (Pl. 35. fig. 26 *a*) is often deeply cleft, its anterior and inner margin elegantly toothed; and to it are attached the labial palpi (fig. 26 *c*). In some the labial palpi and mandibles are absent, the labium forming a kind of sheath or suctorial rostrum.

The internal structure resembles that of the larvæ of insects.

The sexes are separate. The embryo, on escaping from the ovum, has but few legs, sometimes three pairs, at others none, the number being augmented each time the skin is cast; the same applies to the ocelli.

The Myriapoda live in dark places, beneath the bark of trees, under dead leaves, stones, &c.

They form very interesting objects when properly prepared and mounted. The small ones, when slightly compressed between two glasses, dried in that position, subsequently macerated in oil of turpentine, and mounted in balsam, become very transparent, and show the structure beautifully; the nervous ganglia and cords are often very distinctly seen in these specimens without dissection. The abdomen of the longer specimens should be slit up with fine scissors, and the viscera removed—the integument being gently compressed, and dried as above.

Bibl. Newport, *Linn. Tr.* xix.; id. *Phil. Tr.* 1841; Gervais, *Ann. d. Sc. Nat.* 2 sér. vii.; Leach, *Linn. Tr.* xi.; Jones, *Todd's Cycl. An.* iii.; Fabre, *Ann. d. Sc. Nat.* 1855, iii.; Packard, *Amer. Natural.* iv.; Cope, *Tr. Amer. Ent. Soc.* 1870; Lubbock, *Linn. Tr.* 1867; Nicholson, *Zool.* 310; Pascoe, *Zool.* 90; Latzel, *Myr.* 1880.

MYRIONE'MA, Grev.—A genus of Myrionemaceæ (Fucoid Algæ), consisting of minute epiphytic plants, forming patches of short, erect, simple, jointed filaments, springing from a thin expanded layer of decumbent cohering filaments. They are described as bearing oblong "spores;" but these are probably *sporanges* producing zoospores, and it is probable that they are accompanied by septate sporanges, as in *Elachistea*.

M. strangulans. Patches convex, confluent; erect filaments clavate; spores on the decumbent filaments; forms brown dots upon *Ulva*, or little rings round Enteromorphæ.

M. Leclancherii. Circular; erect filaments cylindrical, spores on the decumbent filaments; in patches 1-12 to 1-4″ in diameter; on decaying fronds of *Rhodymenia* and *Ulva*.

M. punctiforme. Patches globose; filaments tapering to the base; spores very narrow, fixed near the bases of the erect filaments; on *Ceramia* and *Chylocladia*.

M. clavatum; obscure.

Bibl. Harvey, *Mar. Alg.* 51; Grev. *Sc. Crypt. Fl.* pl. 300; Harv. *Phyc. Br.* pl. 41 A; Hook. *Br. Fl.* ii. pt. 1. 391.

MYRIONEMA'CEÆ.—A family of Fucoideæ. Olive-coloured sea-weeds, with a tuber-shaped or crustaceous spreading frond, sometimes minute and parasitical. Ovoid unilocular, and filamentous multilocular sporanges attached to the superficial filaments, and concealed among them.

Leathesia. Frond tuber-shaped.

Ralfsia. Frond crustaceous.

Elachistea. Frond parasitical, consisting of a tubercular base bearing pencilled erect filaments.

Myrionema. Frond parasitical, forming a flat base, bearing cushion tufts of decumbent filaments.

MYRIOTHE'LA, Sars.—A genus of Hydroid Zoophytes.

Char. Polypes solitary, cylindrical, terminating in a conical proboscis, springing from an adherent chitinous base; tentacles small, capitate, covering the greater portion of the body; gonophores clustering round the base of the polypes, and containing fixed sporosacs. *M. Phrygia*, on stones.

BIBL. Sars, *Zool. Reise in Lofoten*; Gosse, *Mar. Zool.* 19; Hincks, *Hyd. Zooph.* 75.

MYRIOTRICH'IA, Harv.—A genus of Ectocarpaceæ (Fucoid Algæ), consisting of minute epiphytic plants, forming tufts of capillary filaments on larger Algæ. Filaments simple jointed tubes, set all over with minute, simple, spore-like ramules, which again are clothed with very slender, long, jointed filaments. Fructification composed of oval unilocular *sporanges* on the sides of the main axis, producing zoospores; probably also multilocular sporanges exist.

M. claviformis. Main filament with quadrifarious ramules, increasing in length upwards; fronds 1-2″ long, forming tufts on *Chorda lomentaria.*

M. filiformis. Main filaments very long, often flexuous, set at irregular intervals with oblong clusters of minute papilliform ramules; 1″ or more long; on *Chorda lomentaria* and *Asperococcus echinatus.*

BIBL. Harv. *Phyc. Br.*; *Mar. Alg.* 63; *Hook. Jn. Bot.* i. 300.

MYROTHE'CIUM, Tode.—A genus of Stilbacei (Hyphomycetous Fungi).

M. roridum, Tode, occurs on decayed plants, fungi, &c. It has no peridium, but consists of minute subcylindrical spores seated on a thin base, the whole forming a subgelatinous mass, which is exactly analogous to the fructifying mass of Phalloidei.

BIBL. Berk. *Br. Fl.* ii. pt. 2. 323; Fries, *Sum. Veg.* 448; Cooke, *Handb.* 559.

MYXAS'TRUM, Haeckel.—A genus of Monera.

Char. A simple shapeless protoplasm body without vacuoles, which protrudes simple or ramifying and anastomosing processes. Reproduction by radial fission. The encapsuled resting body divides into a great number of germs, whose longitudinal axis is radially directed towards the centre of the globular cyst. Each separate germ surrounds itself with a siliceous covering. The germs issuing from these spore-coverings at once assume the form of the full-grown organism.

M. radians. Lanzerote, Canaries.

BIBL. Haeckel, *Monog. of Monera* (*Qu. Mic. Jn.* ix. n. s. p. 342).

MYXODIC'TYUM, Haeckel.—A genus of Monera. Simple protoplasm bodies without vacuoles; pseudopodia ramifying, anastomosing, and forming a net. Reproduction probably by division, each individual producing new colonies. *M. sociale.* Bay of Algesiras.

BIBL. Haeckel, *Monera* (*Qu. Mic. Jn.* ix. n. s. 339).

MYXOGAS'TRES=MYXOMYCETES.

MYXOMYCE'TES.—A family of minute Fungi, of curious and interesting structure, characterized by their development from a mucilaginous filamentous matrix, out of which arise sac-like dehiscent sporangia or peridia, emitting a very remarkable, often reticulated, filamentous structure, bearing the spores.

The Myxomycetes grow upon bark of trees, decayed wood, or on leaves (especially under certain atmospheric conditions), or on the ground; and their evanescent mycelium consists of diffluent mucilaginous protoplasmic filaments of varied form and colour. In proportion as these acquire consistence, there is formed a crust common to the whole mass, divided within into chambers, or a number of individuals appear separate from it and associated on a common thallus. In the first case a single peridium is formed, which may be regarded as a common peridium if we consider the inner cells as partial peridia soldered together, while in the second case each individual has its own peridium. This peridium, sessile or stalked, is composed of one or more membranous, papery, or crustaceous coats; in some cases where there are two coats, the outer is crustaceous and persistent, or it is extremely thin and membranous, and breaks up into deciduous scales. In the outer wall

of some peridia, calcareous crystalloids are found. The mode of dehiscence varies. Sometimes an irregular opening is formed at the summit, as in *Physarum*; sometimes the peridium opens like a little box, as in *Craterium* (fig. 145, p. 213); sometimes the upper half falls off, leaving a cup-shaped base, as in *Arcyria*; or the membrane may be very delicate, and break up entirely into little scales, which fall off and leave the *capillitium* with its spores naked, as in *Stemonitis*. The *capillitium* or sporiferous structure is formed of filaments, simple or branched, free and loose, or anastomosing so as to form a network (fig. 147, p. 214); in *Trichia* these have spiral markings, and resemble the elaters of Hepaticæ (Pl. 40. fig. 39). The filaments are often elastic, and when the peridium bursts they rise from the bottom of it, forming a coloured, erect or drooping plume (*Arcyria*). In many species there is a stalk, *columella* or *stylidium*, in the centre of the capillitium. The spores appear to be produced upon these filaments by growing out from them in the manner of basidiospores. They are formed in vast numbers, and lie, when complete, on the branches and in the interstices of the capillitium.

In germination, each spore liberates its entire protoplasm, which exhibits amœboid movements, and protrudes pseudopodia, which anastomose as in *Gromia*. In some instances, these amœboid bodies acquire cilia, resembling Monads. They then conjugate, finally forming a sporangium, in which the capillitium with its very numerous spores are produced. Some authors regard these organisms as animal, but this opinion seems to rest upon partial views.

Synopsis of British Genera.

* Trichiacei. Primary mucilage conjoining several distinct peridia. Filaments of the capillitium free, entwined, elastic, or almost absent.

Licea. Peridium subpersistent, membranous, bursting irregularly. Spores in heaps, with scarcely any filaments.

Perichæna. Peridium persistent, membranous, bursting by a circumscissile slit. Filaments few, free.

Trichia. Peridium simple, persistent, bursting irregularly at the summit. Filaments densely interwoven, elastic.

Arcyria. Peridium simple, membranous, splitting all round at the base, the upper part very fugacious. Filaments densely interwoven, elastic.

** Stemonitei. Primary mucilage connecting several distinct peridia. Filaments conjoined into a network, adnate or innate.

Cribraria. Peridium simple, membranous, the upper part falling off. Filaments adherent in the interior, at length expanding into a free network above.

Dictydium. Peridium simple, subglobose; very delicately membranous, bursting indeterminately, leaving the filaments (innate) forming a cage-like latticed capillitium.

Stemonitis. Peridium simple, globose or cylindrical, delicately membranous, finally evanescent. Filaments forming a determinate capillitium, attached to a bristle-like central columella, and forming a network around it.

Diachæa. Peridium simple, ovate-oblong, membranous, detached in fragments, leaving a radiately reticulate capillitium, with a floccose grumous pulverulent axis.

Enerthenema. Peridium simple, globose, membranous, at length evanescent, laying bare a conical columella with a cup at the summit, bearing beneath ascending entwined filaments.

*** Physarei. Primary mucilage spreading widely, passing into many peridia. Filaments adnate, straight, vague. Spores black.

Craterium. Peridium simple, varied, papery, persistent, closed by a lid, which finally falls off. Capillitium somewhat chambered, formed of crowded filaments, at length erect.

Physarum. Peridium simple, variable, naked, membranous, bursting irregularly. Capillitium floccose; filaments at first joined into a net or forked.

Didymium. Peridium double; the outer bark-like, breaking up into little furfuraceous scales or mealy down, the inner membranous, bursting irregularly; filaments vague, adnate to the peridium.

Diderma. Peridium double; outer crust-like, distinct, brittle, dehiscent, the inner very delicately membranous, evanescent; filaments vague, adnate to the base.

**** Æthalinei. Primary mucilage producing one peridium.

Spumaria. Peridium indeterminate, crustaceous, divided into cells by regular ascending folds, and finally falling away. No internal filaments.

Æthalium. Peridium indeterminate, fragile, falling away, covered with a floccose

bark externally, cellular internally by means of filaments conjoined into membranous layers.

Reticularia. Peridium indeterminate, simple, naked, fugacious, bursting irregularly, laying bare branched, reticulated adnate filaments.

Lycogala. Peridium determinate, composed of a double membrane, membranous, somewhat warty, persistent, bursting at the summit. Filaments adnate on all sides of the peridium.

Bibl. Schmitz, *Linnæa*, xvi. 188; De Bary, *Die Mycetozoa*, 1864; Hofmeister, *Phys. Bot.* ii. 295; Cienkowsky, *Jahr. wiss. Bot.* iii. 325, 400; Kent, *Inf.* 470; Sachs, *Bot.* 265; Cooke, *Myxomyc.* 1877.

MYXOR'MIA, Berk. and Br.—A genus of Coniomycetes, containing one species, *M. atroviridis*, forming minute cup-like bodies, on dead leaves of grass. It is allied to *Excipula*, but differs in its concatenate spores being connected by a slender thread, which frequently breaks off with them; spores very gelatinous.

Bibl. Berk. and Br., *Ann. N. H.* 2 ser. v. 457; Cooke, *Handb.* 459.

MYXOT'RICHUM, Kze.—A genus of Dematiei (Hyphomycetous Fungi), growing on rotten wood, paper, &c. Three British species: *M. cæsium*, Fr.; *M. chartarum*, Kze.; and *M. deflexum*, Berk. They form little tufts or downy balls, sending off radiating branched filaments. The spores are described as occurring collected in masses about the base of the threads.

Bibl. Berk. *Br. Fl.* ii. pt. 2. 335; *Ann. N. H.* i. 260, pl. 8. fig. 9; Fries, *Sum. Veg.* 502; *Syst. Myc.* iii. 348; Church, *Ann. N. H.* 1862.

MY'ZUS, Passerini.—A genus of Aphidæ. Four species; on the cherry-tree, peach and nectarine, red-currant and gooseberry. (Buckton, *Aphides*, i. 173.)

N.

NACCA'RIA, Endl.—A genus of Cryptonemiaceæ (Florideous Algæ), containing one rare British species, *N. Wigghii* (Pl. 4. fig. 18), usually thrown up from deep water. Its rose-coloured frond is 6 to 12″ high, and consists of a branched filiform expansion, the central axis being about as thick as a crow-quill, the branchlets quadrifariously alternate and clothed with ramules about 1-12″ long. The cells of the main axis and branches of the frond are large and empty in the centre, small and closely packed at the circumference; the ramules are composed of jointed dichotomous filaments having a whorled arrangement, surrounded by gelatinous matter. The spores are borne on branches of the filaments of the ramules, the fertile ramules being swollen in the middle.

Bibl. Harvey, *Mar. Alg.* 152, pl. 20 D; *Phyc. Br.* pl. 38; Greville, *Alg. Br.* pl. 16.

NAÏDINA.—A family of Setigera (Annulata).

Char. Worm-like, annulate or segmented, without suckers or soft leg-like appendages; segments furnished with partially retractile bristles or setæ, excepting the first three or four; head distinct from the body.

Freshwater animals, living among aquatic plants, or burrowing in mud. Sexes distinct; propagation by ova and spontaneous transverse division. The bristles are moved by muscles, and answer the purpose of legs; they are situated on the upper or under surface of the body, mostly in rows.

The Naïdina are remarkable for the singular process of non-sexual multiplication which they present before attaining sexual maturity. A bud is thrown out between two rings near the middle of the body, and is developed into a fresh individual; moreover the parent body separates at this point, and becomes two individuals; and prior to the detachment of the bud, others are formed from the same segment.

Nais, Müll. Four anterior segments without upper bristles.

N. Scotica. Cylindrical, ends obtuse, the anterior smooth and cylindrical, the portion behind it with a double row of thin tufts of prickles, shorter than the diameter of the body; mouth and anus terminal; no proboscis; length 1″.

N. serpentina. Cylindrical; head snake-like, with a produced lower lip; eyes two; upper bristles subulate, lower forked or hooked; length about 1½″. The lower bristles with a globular swelling below the middle; segments 80–90; head with 4 dark transverse bands.

N. proboscidea. Cylindrical, flattened in front; first four segments divided by a stricture from the body, the first or head being prolonged into a filiform proboscis; two eyes; upper bristles simple, lower forked; length 1-2″; on the roots of aquatic plants.

Chætogaster, Baer. All the segments without upper bristles.

C. vermicularis. Truncate in front: no

eyes; mouth terminal; setæ bifid; length 1″; among *Lemna*, in ditches, and in the respiratory chamber of the Lymnæidæ.

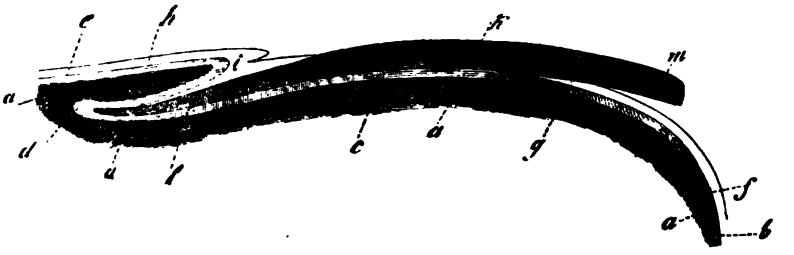
See TUBIFEX.

BIBL. Schmidt, *Müller's Archiv*, 1846, 406; Dugès, *Ann. Sc. Nat.* 2 sér. xv. 319; Johnston, *Cat. non-parasit. Worms*; Doyère, *Mém. Linn. Soc. Normandy*, x.; Claparède, *Rech.* 1861.

NAILS.—These organs, which consist of modified epidermic formations, are imbedded posteriorly and laterally in depressions, or are covered at these parts by a fold of the skin. The posterior depression (fig. 505 *d*) is much deeper than the lateral depressions (fig. 506 *c*).

The nail itself consists of the root (fig. 505 *l*), the body (*k*), and the free end (*m*). The root extends over that part of the matrix furnished with the ridges, and is

Fig. 505.



Longitudinal section through the middle of the nail and its matrix. *a*, matrix and cutis of the back and point of the finger; *b*, rete mucosum of the point of the finger; *c*, that of the nail; *d*, that of the bottom of the root-fold; *e*, the same of the back of the finger; *f*, epidermis of the point of the finger; *g*, its origin beneath the margin of the nail; *h*, epidermis of the back of the finger; *i*, its termination at the upper surface of the root of the nail; *k*, body, *l*, root, *m*, free end of the proper nail.

Magnified 8 diameters.

either entirely lodged in the posterior depression of the cutis, or the crescentic portion of it is exposed. The body of the nail is uncovered except at the sides, which are overlapped by the lateral folds of the skin.

The portion of the cutis (fig. 506 *a*) to which the under surface of the nail, except that of the anterior free portion, is attached —the matrix or bed—is covered with ridges (fig. 506 *a*) extending from the posterior part or root of the nail to the convex margin of the white crescentic portion called the lunule, where they become larger and higher, forming plates which run to the end of the matrix. The margins of the ridges and plates are covered with short papillæ. The anterior portion of the matrix of the nail is very vascular.

The under surface of the root and body of the nail is covered with depressions and ridges to adapt itself to those of the matrix.

Two layers are distinguishable in the nails—an under soft layer (figs. 505 *d*, 506 *c*, 507 *B*), corresponding to and directly continuous with the rete mucosum of the skin, and the upper horny layer forming the true nail (figs. 506 *f*, 505 *k*, 507 *C*). The lower surface of the latter is furnished with small ridges (fig. 507 *c*), which occupy corresponding furrows in the mucous layer.

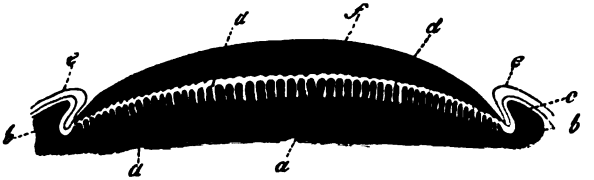
In minute structure the soft layer resembles that of the cutaneous rete, except in the deeper layer of cells being elongated and arranged perpendicularly (fig. 507 *b*).

The horny portion, or proper nail, consists of epidermic cells, flattened and aggregated into plates or laminæ (fig. 507 *C*). In the natural state, these cells are undistinguishable, except at the root and the under surface, where the nail is in contact with the mucous layer—the remainder merely exhibiting shorter or longer dark lines, representing the flattened nuclei, or indicating the existence of the laminæ. But if a section of nail be treated with solution of caustic potash or soda, the nucleated cells swell up, and resume their proper form and appearance.

The blood-vessels of the bed of the nail form a coarse plexus in the corium of the matrix, from which loops are given off to the papillæ; and the proper bed of the nail has a much finer plexus and loops ascending to the ridges.

Numerous medullated nerve-fibres lie in the subcutaneous tissue of the nail-bed, and

Fig. 506.

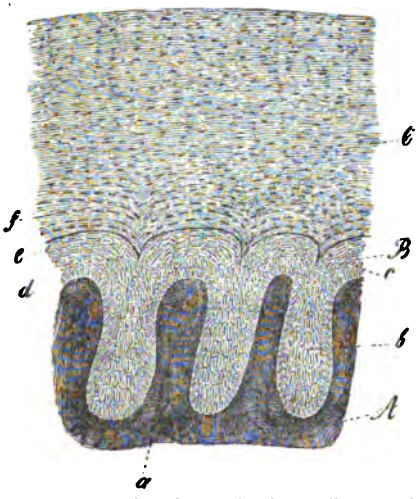


Transverse section of the nail and its matrix. *a*, matrix with its ridges (black); *b*, cutis of the lateral fold; *c*, rete mucosum of the same; *d*, rete mucosum of the nail with its ridges (white); *e*, epidermic layer of cutaneous fold; *f*, proper substance of the nail, with short teeth on its under surface.

Magnified 8 diameters.

lose their medullary sheath at the level of the corium, and then run vertically to the surface.

Fig. 507.

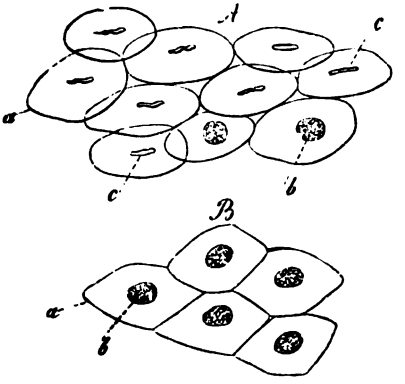


Transverse section of the body of the nail. *A*, cutis of the matrix. *B*, rete mucosum of the nail. *C*, epidermis of the same, or proper nail. *a*, plates of the matrix; *b*, plates of the rete mucosum of the nail; *c*, ridges of the proper substance of the nail; *d*, deeper perpendicular cells of the rete mucosum of the nail; *e*, upper flattened cells of the same; *f*, nuclei of the cells of the proper nail.

Magnified 250 diameters.

The cutaneous epidermis (fig. 506 *e*) extends for a certain distance into the lateral and posterior depressions of the skin, covers the anterior portion of the root, the posterior part of the body, and the lateral margins of the nails, terminating in a fine layer which, however, is nowhere directly continuous with the substance of the nail.

Fig. 508.



Laminæ of a nail after boiling with solution of caustic soda or potash. *A*, side view. *B*, surface view. *a*, cell-membranes; *b*, nuclei seen from above; *c*, the same in side view.

Magnified 350 diameters.

BIBL. Kölliker, *Mik. An.* ii. and the *Bibl.* therein; Biesiadecki, *Stricker's Hist.*

NAIS, Müll. See NAÏDINA.

NANNOPUS, Brady.—A genus of Copepodous Entomostraca. (Brady, *Cop.* ii.)

NAR'COTINE. See ALKALOIDS, p. 31.

NAS'SULA, Ehr.—A genus of Holotrichous Infusoria, of the family Trachelina.

Char. Body covered with cilia arranged in longitudinal rows; mouth surrounded by a cone of rod-like teeth; no proboscis nor ear-like processes.

The gastric sacculi of these animals frequently contain a coloured liquid, derived from the solution of partly digested *Oscillatoriæ*.

N. elegans (Pl. 31. fig. 45; *b*, teeth). Length 1-144 to 1-120".

N. aurea (Pl. 31. fig. 46). Length 1-120".

It is questionable how far this genus is different from *Chilodon*.

BIBL. Ehr. *Infus.* 338; Stein, *Inf.* 248; Cohn, *Qu. M. Jn.* 1859; Clap. et Lachm. *Etudes*; Kent, *Inf.* 494.

NAU'PLIUS. See CRUSTACEA, p. 216.

NAVICELLÆ. See GREGARINA, p.365.

NAVIC'ULA, Bory.—A genus of Diatomaceæ.

Char. Frustules single, free; valves oblong, lanceolate or elliptical, sometimes with the ends narrowed and produced, rarely constricted in the middle, furnished with a longitudinal line or keel, and a nodule in the middle and at each end; surface of valves covered with dots arranged in transverse or slightly radiating rows, producing an appearance of lines, although both dots and lines are often invisible by ordinary illumination.

Valves usually symmetrical, and the keel median; but in two species the keel is sigmoid and the valves inequilateral. Sometimes the keel is double. There is mostly a little space between the rows of dots (Pl. 15. fig. 8), so that these readily exhibit transverse lines or striæ by unilateral oblique light; but sometimes they are pretty uniformly distributed, as in many of the species belonging to the first section of *Pleurosigma*.

Species or forms very numerous; Kützing describes 170, some of them, however, belonging to *Pinnularia*, *Pleurosigma*, and other genera. Rabenhorst notices 237 species. Many may have been derived from a frustule of a *Schizonema* or *Colletonema* which had escaped from its gelatinous envelope!

The formation of sporangial frustules has been noticed by us in *Navicula amphirhynchus*, and they are contained in a siliceous sporangial sheath or case. The process is sufficiently illustrated by the figures (Pl. 50. figs. 19–24): fig. 19, side view of the parent frustule; fig. 20, front view of conjugating frustules, with young sporangial sheath; fig. 21, empty mature sheath; fig. 22, crushed empty sheath and parent frustules *in situ*; fig. 23, sheath, one parent frustule and sporangial frustule in front view; fig. 24, sporangial frustule in side view.

N. cuspidata (Pl. 15. fig. 6, side view; fig. 7, front view; *a*, hoop). Valves lanceolate, somewhat rhomboid, acuminate; freshwater; length 1-350 to 1-200″. Valves slightly iridescent, no striæ by ord. illum.

N. didyma (Pl. 15. fig. 9). Valves elliptic oblong, slightly constricted in the middle; marine; length 1-600 to 1-300″. Ends sometimes broadly rounded, and the constriction very deep.

N. rhomboides. Valves rhomboid-lanceolate; colourless and not striated by ordin. illum.; freshwater; length 1-350″. Striæ 85 in 1-1000″ (Sm.).

N. amphirhynchus (Pl. 50. fig. 19, side view; fig. 22, front view of conjugating frustules). Valves linear, or nearly so, suddenly contracted near the produced and obtuse ends; freshwater; length 1-500 to 1-250″.

N. affinis. Valves elliptical, contracted and linear towards the rounded ends; freshwater.

BIBL. Smith, *Br. Diat.* i. 46; Kütz, *Bacill.* 91, and *Sp. Alg.* 69; Grev., n. sp., *Mic. Tr.* 1866, 84 & 126; O'Meara, pec. forms, *Qu. Mic. Jn.* 1872, xii. 283; Rabenh. *Alg.* i. 169.

NEBA'LIA, Leach.—A genus of Phyllopodous Entomostraca.

Char. Antennæ two pairs, large and ramiform; eyes two, stalked; legs twelve pairs, eight branchial and four natatory; carapace large, enclosing head, thorax, and part of abdomen.

N. bipes (Pl. 19. fig. 28). Marine; body yellowish; length 3-8″.

BIBL. Baird, *Br. Entom.* 36; Claus, *Sieb. & Köll. Zeits.* 1872, 323; *An. N. H.* 1879, iv. 418.

NECKE'RA, Hedwig.—A genus of Hypnoid Mosses.

Elegant little perennial plants, growing on trunks of trees and shady rocks, having stems pinnately branched, bearing complanate leaves arranged in eight rows (fig. 484).

N. crispa, Dill., found in mountainous districts, is a large moss, with stems 4 or 6″ long or more, growing horizontally from a creeping rhizome.

NECTRIA, Fries.—A genus of Sphæriacei (Ascomycetous Fungi), distinguished from true *Sphæriæ* by the free, membranous, flaccid, brightly coloured perithecium, the pale papilla, and the gelatinous pale nucleus expelled in the form of a drop or of white flocks; the asci contain eight pellucid spores. The imperfect forms of these plants are described as distinct genera. Thus *Tubercularia vulgaris*, common on bark of dying or dead trunks, and on dead twigs of birch especially, ripens into *N. cinnabarina*; this we have observed; and it is probable that other Coniomycetous forms will require to be reduced in like manner. *Nectria*

includes the following *Sphæriæ* of the British Flora—*cinnabarina, coccinea, ochracea, aurantia, rosella, citrina, Peziza, sanguinea, epispharia*, &c.; and several new species are described by Messrs. Berkeley and Broome.

Bibl. Fries, *Sum. Veg.* 387; Berk. & Broome, *Ann. N. H.* 2 ser. xiii. 467; Cooke's *Handb.* 780.

NEMA'LEON, Targioni. — A genus of Cryptonemiaceæ (Florideous Algæ), containing two British species, one, *N. multifidum*, not uncommon on shells and stones near low-water mark. Its frond consists of a somewhat cartilaginous, simple or once or twice dichotomous cord, 3 to 6″ high and 1 to 2′ in diameter, of a dull purple colour. The cord consists of a dense axis formed of interlaced longitudinal filaments, clothed with horizontal, dichotomously-branched filaments, moniliform and coloured towards the circumference of the cord. The fruit consists of:—*favellidia*, consisting of globular masses of spores attached singly to the filaments of the periphery, with a trichogyne (Pl. 4. fig. 12 *c*); and collections of *antheridia*, consisting of minute hyaline cells seated on the peripheral filaments, but discharging spermatozoids (Pl. 4. fig. 12 *b*).

Bibl. Harv. *Mar. Alg.* 153, pl. 21 B, *Phyc. Br.* pl. 36; Derbès and Solier, *Ann. Sci. Nat.* 3 sér. xiv. 274, pl. 35; Thuret, *ibid.* 4 sér. iii. 21.

NEMAS'PORA, Fries.—A supposed genus of Melanconiei (Coniomycetous Fungi), the species of which present two forms, one bearing minute conidia (*Nemaspora*), the other spores (*Libertella*, Desmaz.), and which probably also will be found to exhibit an asciferous form. *N. crocea*, Pers., is common on beech trees, *N. Rosæ* on roses and lilacs. They are at first minute gelatinous masses of conidia, coherent into a nucleus under the epidermis, devoid of a perithecium; the spores finally exude as a gelatinous tendril; the spores are curved and of an orange-colour. *Nemaspora* consists really of spermogonous fruits, and *Libertella* of stylosporous fruits of Ascomycetous genera.

Bibl. Berk. *Br. Fl.* ii. pt. 2. 355; Fries, *Sum. Veg.* 413; Desmaz. *Ann. Sc. Nat.* 1 sér. xix. 269.

NEMATHE'CIA.—Wart-like collections of vertical filaments found on the surface of the fronds of the Cryptonemiaceæ (Florideæ).

NEOTTIOS'PORA, Desmaz.—A genus of Sphæronemei (Stylosporous Fungi), remarkable from the fusiform spores being furnished with three or four terminal threads. *N. caricum* grows upon dead leaves of sedges, bursting from beneath the epidermis by a circular black orifice, from which an orange-coloured (sometimes olive-coloured) gelatinous mass of spores escapes in the form of a cirrhus. Diameter of conceptacles about 1-80″.

Bibl. Desmazières, *Ann. Sc. Nat.* 2 sér. xix. 346; Berk. & Broome, *Ann. N. H.* 2 ser. xiii. 379.

NE'PA, Linn.—A genus of Hemipterous Insects.

N. cinerea, the common water-scorpion, is of a dirty brown colour, the body broad and flat, with two long terminal respiratory tubes; anterior pair of legs stout and greatly elbowed, posterior formed for crawling and not swimming.

Pl. 33. fig. 26 represents the trophi. The labium (*i*) is three-jointed, with two small lobes between the second and third joints; the four setæ (mandibles and maxillæ) are furnished with teeth, directed towards the free end (and not as shown in the figure); the lingua or tongue (*) is trifid at the apex.

The lateral tracheæ are dilated opposite the thorax to form two internal respiratory sacs. The eggs are oval, and with seven reflexed filaments at one end.

Bibl. Westwood, *Intr.*; Dufour, *Hémiptères.*

NEPEN'THES, L.—A genus of Nepenthaceæ (Dicotyledonous Plants), in which the spiral vessels have four parallel fibres (see Spiral Structures).

NEPHROCY'TIUM, Näg.—A genus of Palmellaceæ; consisting of 4–16 minute reniform green cells, enclosed in an ample envelope. 2 species; in ditches and boggy pools. (Rab. *Fl. Alg.* 52; Näg. *Einzell. Alg.* 79.)

NEPHRO'DIUM, Rich.—A genus of Aspidieæ (Polypodiaceous Ferns, fig. 224. p. 320). A very large number of species, cosmopolitan. Brit. sp.: *N. Filix-mas, Thelypteris, Oreopteris* (*montanum*), *rigidum, cristatum, spinulosum* (*dilatatum*), and *æmula.*

NEPHRO'LEPIS, Schott.—A genus of Aspidieæ (Polypodiaceous Ferns). 7 species, tropical. (Hooker, *Syn.* 300.)

NEPHRO'MIUM, Nyl.—A genus of Lichenaceous Lichens. Three species; rare. (Leighton, *B. Lich. Fl.* 99.)

NEPHROSEL'MIS, Stein.—A genus of

Flagellate Infusoria. Free, solitary; flagella two, arising from the middle of the ventral side. *N. olivacea*, reniform; length 1-1000″; freshwater. (Kent, *Inf.* 405.)

NERIUM. See STOMATA, and LIBER (p. 461).

NERVES and NERVOUS CENTRES.—The nervous system is usually regarded as consisting of two parts—the nerves, which are divided into the cerebro-spinal and the sympathetic; and the nervous centres, represented by the brain and spinal cord, with which must also be placed the ganglia. These parts are composed essentially either of nerve-tubes, nerve-cells, or of both these elements.

The nerve-fibres may be arranged in two groups, the medullated and the non-medullated.

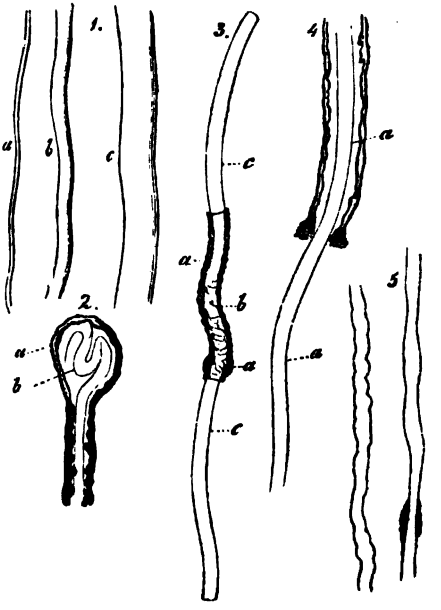
The *medullated* nerve-tubes are most numerous in the white portion of the nervous centres and in the nerves. They are slender, soft, cylindrical filaments, varying in diameter from 1-20,000 to 1-1100″. When quite recent, they are transparent and apparently homogeneous (fig. 509, *1*), but they really consist of three distinct parts—an enveloping membrane or sheath; a tenacious liquid, the white substance of Schwann; and a soft, elastic, and probably fibrous axis, the axis-cylinder, or band of Remak.

The outer sheath or tubular membrane of the nerve-tubes is a thin structureless transparent membrane (fig. 510, *2*, *3 a*, *4 a*), containing nuclei. It is very visible and thick in the nerves of the mesentery of the frog, and in the electrical organs of the torpedo. It is furnished with annular constrictions at regular intervals.

Within the outer sheath is a hollow cylinder or tube (figs. 509, *3 b*, 510, *3 b*, *4 b*)—the white substance of Schwann. It is homogeneous and tenacious in perfectly fresh nerves, but soon after death becomes coagulated, sometimes externally only, giving a double outline to the walls of the nerve-tubes (fig. 510, *4*, 511), or becoming granular externally, and remaining liquid internally. It is also easily altered by pressure, sometimes escaping in globules or masses of various forms (myeline), from the ends or the broken sides of the tubes, at others accumulating at intervals in various parts of the tubes, giving them an elegant varicose appearance (fig. 511). It is frequently called the medullary sheath, and those nerves possessing it are medullated.

The third structure exists within the last, in the form of a rounded or flattened, pale, fibrous band, occupying the axis of the tube, and called the axis-cylinder (figs. 509, *2 b*, *3 c*, *4 a*, *5*; 510, *1 b*); this is the essential nervous element.

Fig. 509.



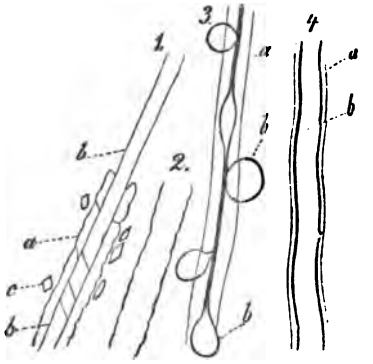
Nerve-fibres. 1. From nerves of the dog and rabbit, in the natural state: *a*, fine, *b*, moderate, *c*, large fibre. 2. From a frog, after the addition of serum: *a*, drop forced out by pressure; *b*, part of the axial fibre contained in it. 3. From the human spinal marrow, treated with serum: *a*, sheath; *b*, white substance with a double outline; *c*, axial fibre. 4. Fibre with double outline, from the human fourth ventricle: *a*, axial fibre. 5. Two isolated axial fibres, with a portion of the white substance adherent to the right-hand one.

Magnified 350 diameters.

These three structures of nerve are somewhat difficult of demonstration. The outer sheath may sometimes be shown by pressing the nerve-tube, which forces out the white substance. Boiling the nerves in absolute alcohol, with the subsequent addition of caustic alkali, or in acetic acid, when crystals of fat separate from the white substance (fig. 510, *1*), will answer the same purpose. Strong nitric acid, and afterwards potash, causes the white substance to exude; and the axial fibre being dissolved, the yellow sheath is left empty and very distinct. Solution of corrosive sublimate has also been

recommended. The axial band is best seen in nerves treated with strong acetic acid, or cold absolute alcohol, ether, chromic acid,

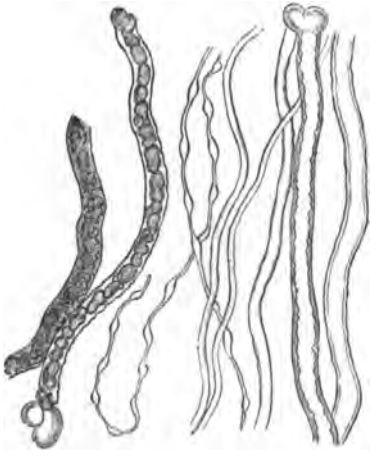
Fig. 510.



Nerve-tubes. 1. From a frog, after boiling with acetic acid and alcohol: *a*, sheath; *b*, axial band; *c*, crystals of fat. 2. Isolated sheath of a frog's nerve boiled with soda. 3. From the human fourth ventricle, after treatment with soda: *a*, sheath; *b*, white substance exuding in drops: the axial band has been removed in the preparation. 4. Human, treated with soda: *a*, sheath; *b*, white substance; the axial band not visible.

Magnified 350 diameters.

Fig. 511.



Human nerve-tubes, showing tubes of various sizes; some with a single, others with a double outline; some varicose, others with the white substance in a granular state.

Magnified 350 diameters.

&c., and staining fluids. Osmic acid solution hinders the coagulation of the medullary substance, which is oily and very refractive, and turns it black.

Chemically, the sheath and axial band consist of a proteine compound, and the white substance of a mixture of cerebrine with lecythine.

In the *non-medullated* nerves the fibres are of three kinds. The primitive nerve-fibrils present the simplest form, and are very fine and thread-like. They are only visible with powers greater than 500 linear, and may be traced to their junction with ganglion-cells and thicker nerve-fibres. No internal structure can be distinguished; and they become varicose here and there with reagents, such as osmic acid, finally becoming diffluent. They abound in the neighbourhood of the termination of other nerves, for instance, in the retina (see EYE).

The second kind of fibres have been called naked axis-cylinders, and are thicker than the primitive fibrils. They are transparent, and more or less striated longitudinally, being composed, like the axis-cylinders of medullated nerves, of minute longitudinal fibrils. When connected with multipolar ganglion-cells, this fibrillation is often distinct under the action of reagents. They have only been traced for short distances; and it is evident that they and the primitive fibrils may become covered with a sheath and merge into the medullated type. The third kind consists of a thicker or thinner bundle of primitive nerve-fibrils, according to the kind of axis-cylinder present, united together by a structureless, perfectly transparent, extremely thin nucleated tissue—the tubular sheath of the medullated fibres.

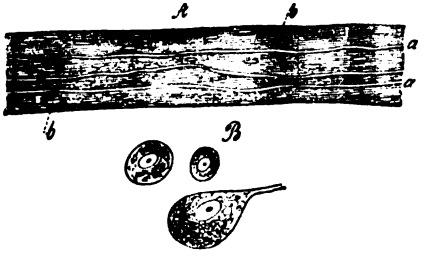
In the cerebro-spinal nerves, the nerve-tubes are aggregated into bundles, and surrounded by an envelope of connective tissue, called the neurilemma, in which blood-vessels ramify, thus corresponding with the arrangement of the primitive fibrillæ of muscle. Sometimes, towards the terminations of the nerves, the neurilemma appears as a homogeneous membrane with elongated nuclei.

Branching or division of all the nerve-fibres, except the non-medullated primitive kind, occurs occasionally in and near the nervous centres and in the nerve-trunks, and frequently in the periphery. The best example of peripheral divison is in the electric eel, where one medullated fibre divides millions of times to supply the subcutaneous fat-like organ. Division into fibres may be seen in sections of the spinal

cord of the ox treated with carmine and ammonia.

In the grey, sympathetic, or ganglionic nerves, the fibres of which are sometimes called gelatinous fibres, the nerves are paler than those of most of the cerebro-spinal nerves, and they are scattered through

Fig. 512.



From the human sympathetic. *A*. Portion of a grey fibre treated with acetic acid: *a*, fine nerve-tubes; *b*, nuclei of Remak's fibres. *B*. Three ganglion-globules, one with a pale process.

Magnified 350 diameters.

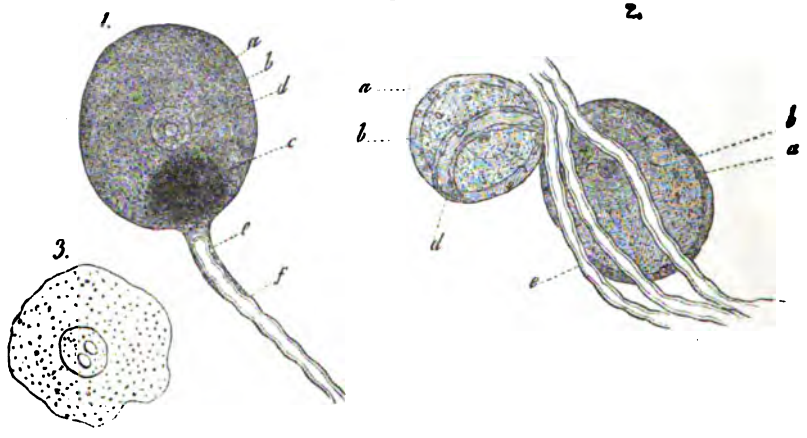
numerous longitudinal non-medullated fibres (Remak's fibres), containing elongated nuclei (fig. 512).

Nerve-cells, nerve-corpuscles, or ganglion-globules are masses of fibrillar protoplasm, granular and faintly coloured; they have a nucleus and nucleolus. They are most numerous in the cineritious or dark portions of the nervous centres, and in the ganglia; but they are met with in the trunks and terminal expansion of nerves, as the retina, &c. Some are furnished with a nucleated capsule (fig. 513, *2 a*); this is easily seen in the cells of the ganglia, but with difficulty in those of the central organs.

They are rounded, elongate, pyriform, or angular (fig. 513). Some are simple, others are furnished with one, two, or more simple or branched processes; hence they are described respectively as uni-, bi-, or multipolar. Their contents are a soft, tenacious, but fibrillar mass (fig. 513, *3*), consisting of a clear, homogeneous, proteine basis, and a number of larger and smaller granules, as well as a nucleus and nucleolus. In size they are very variable, from 1-5000 to 1-500″. The granules are sometimes colourless, at others yellow, brown, or black; and occasionally these are aggregated to form a mass.

A number of fine fibres radiating from the nucleus and nucleolus may be seen traversing the cell-substance, which contains granular, yellow, or reddish-brown pigment. Chloride of gold renders the nucleus very distinct. Beale has shown that two processes are given off from the

Fig. 513.



Nerve-cells and fibres from the auditory nerve. 1. Nerve-cell with the origin of a fibre, from the anastomosis between the facial and auditory nerve in the meatus auditorius externus of the ox: *a*, cell-membrane; *b*, contents; *c*, pigment; *d*, nucleus; *e*, prolongation of the sheath upon the nerve-tube; *f*, nerve-tube. 2. Two nerve-cells with tubes from the auditory nerve of the ox: *a*, sheath with nuclei; *b*, protoplasm, fibrillar really; *c*, nucleus; *d*, origin of tube, with nucleated sheath; *e*, tubes. 3. Separate contents of a nerve-cell with a nucleus and two nucleoli.

Magnified 350 diameters.

small end of the bell-shaped ganglion-cells of the sympathetic in the frog, and that whilst one pursues a straight course, the other forms a series of coils around it, both lying within a nucleated sheath continuous with that of the ganglion-cell.

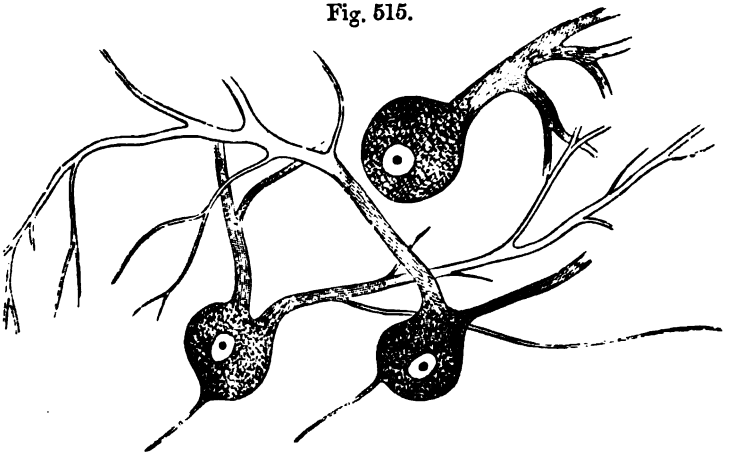
Fig. 514.

Cells from the central grey substance of the human spinal marrow. Some are connective-tissue cells. Magnified 350 diameters.

Origin of Nerve-fibres.— The ganglion-cells, whether multipolar or unipolar, are in continuity with nerve-fibres. Some ganglion-cells are merely nucleated dilatations of the axis-cylinder; and others, which are also bipolar, are true ganglion-cells; for the more or less globular cell-mass is continuous with the axis-cylinder and with the granular matter of the medullary matter, but the tubular sheath of the nerve stops short of the cell.

Multipolar ganglion-cells are invariably connected with one medullated nerve-fibre, which passes off without branching or diminishing in calibre. Its axis-cylinder is continuous with the fibrillar structure of the protoplasm of the ganglion-cell, and it becomes invested with the medullary sheath soon after leaving the cell. The other processes either communicate with adjacent multipolar cells, or break up after repeated branching into a great number of processes, which, however, are clearly continuous with the fibrillar protoplasm of the cell, but are uncovered by any medullary sheath. Their ultimate termination is doubtful; but it is inferred that many of them become continuous with the axis-cylinders of nerves. So

Fig. 515.



Large cells from the grey cortical layer of the human cerebellum. Magnified 350 diameters.

fibrillar are the processes under reagents, and so fibrous is the appearance of the ganglion cell-mass, deficient as it is of cell-wall, that it is imagined that the fibrous structure of the axis-cylinders is continuous with that of each other through the cell-substance.

Doubtless many nerve-fibres originate from very small cells imbedded in the grey substance, and which are usually destroyed by the processes of preparation.

The *ganglia* (fig. 516) consist of nerve-tubes either separate or united into bundles, intermingled with nerve-cells, from which some of the nerve-tubes arise. The tubes and cells are imbedded in or supported by a stroma of connective tissue, sometimes homogeneous, at others more or less distinctly fibrous, forming an apparent sheath to the ganglia, and ending in numerous septa, rarely but occasionally forming a distinct envelope to the individual cells; sometimes it consists of elongated, triangular, or spindle-shaped nucleated cells — in short, corresponding to connective tissue in various stages of development.

The finer nerve-fibres are often with difficulty distinguished from fibres of connective tissue; but the frequent occurrence of nuclei will often serve to distinguish them.

The nerves are developed from the elementary embryonic cells, which at first appear rounded or slightly elongated and

Fig. 516.

Fig. 517.

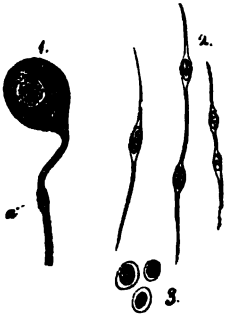


Fig. 518.

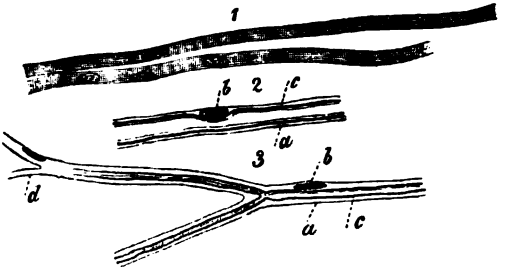


Fig. 516. Sixth thoracic sympathetic ganglion of the left side of a rabbit, seen from behind, after treatment with soda. *T.* 2, trunk of sympathetic; *R. c*, communicating branches, each bifurcating; *Spl.* splanchnic branch. *S*, ganglial branch, with large and small branches probably going to vessels; *g*, ganglion-globules and ganglial fibres. Magnified 40 diameters.

Fig. 517. 1. Ganglion-globules from a spinal ganglion of a four-months human fœtus: *a*, nucleus in the pale process of the cell. 2. Nerve-tubes in development, from a two-months human fœtus. 3. Cells from the cinerious cerebral substance of the same fœtus.

Fig. 518. 1. Two nerve-fibres from the ischiatic nerve of a four-months fœtus. 2. Nerve-tubes from a newly-born rabbit: *a*, sheath; *b*, nucleus; *c*, white substance. 3. Nerve-fibre from the tail of a tadpole: *a*, *b*, *c*, as above; at *d* the fibre has still the embryonic character.

somewhat flattened. In their further growth they either retain their primitive shape (fig. 517), or send out persistent lateral processes, so forming nerve-cells or ganglion-globules; or the processes of adjacent cells unite into nucleated fibres, much resembling those of the sympathetic system, in which the white substance and axial fibre of the

nerve-tubes are formed as secondary deposits (fig. 518).

In atrophy and degeneration of the nervous elements, the nerve-cells become loaded with fat and pigment, and the walls of the nerve-tubes thinner, brittle, and the white substance more or less replaced by granules of fat.

The nerve-fibres are very difficult of examination, and require a high power. They may be hardened in chromic acid or Müller's liquid. Chloride of gold with the subsequent addition of very dilute acetic acid, brings to light the axial fibre; while the medullary sheath is darkened by osmic acid.

BIBL. Kölliker, *Mik. An.* 2; Todd, *Cycl.* iii.; Gerlach, *Mik. Stud.*; Remak, *Monatsb. Acad. Berlin*, 1853; Schultze, *Struct. nerv.*, 1868; Lister & Turner, *Qu. Mic. Jn.* 1860, 29; Mayer, *Strick. Hist.*; Meynert, *ibid.*; Deiters, *Gehirn u. Mark d. Mensch.*, 1865; Clarke, *Phil. Tr.* 1868; Beale, *Phil. Tr.* 1860, 1862, 1863, 1864, *Croon. Lecture* 1865, *Qu. Mic. Jn.* n. s. vols. iv. & v., & *How*; Cleland, *Qu. Mic. Jn.* 1870, 126; Darwin, *Qu. Mic. Jn.* 1874, 110; Schmidt, *M. Mic. Jn.* 1864, 200; Frey, *Hist.* 624; Bevan, *M. Mic. Jn.* xvi. 105.

NEUROGLIA.—A granular connective tissue, with fine elastic fibres and cells surrounding the nerve-fibres in the brain and spinal cord.

NEUROP'TERA.—An order of Insects, containing the Dragonflies (LIBELLULIDÆ).

NEW-ZEALAND FLAX. See PHORMIUM and TEXTILE SUBSTANCES.

NEWT. See TRITON.

NICOTH'OE, Aud. & Edw.—A genus of Crustacea, of the order Siphonostoma, and family Ergasilidæ.

N. astaci (Pl. 19. fig. 36, fem.) is found upon the gills of the lobster.

The sides of the body are extended into two remarkable lobes, containing the ovaries (*a*) and the intestinal canal.

BIBL. Baird, *Br. Ent.* 300; Van Beneden, *Ann. Sc. Nat.* 3 sér. xiii.

NIDULARIA'CEI.—A small family of Gasteromycetous Fungi, including the Nidularini or bird's-nest-like Fungi, and the Carpoboli, which contain only one conceptacle. They are curious and very interesting Fungi, growing on the ground among decaying sticks, dung, &c., bearing upon the flocculent mycelium yellow or dull-coloured fruits or receptacles (fig. 519). The external part of the receptacle consists of a more or less globular or ovate *peridium*, which bursts when mature, in the Carpoboli by a lid or by more or less regular slits, in the Nidularini by an orifice which enlarges

Fig. 519.

Fig. 520.

Cyathus vernicosus.

Fig. 519. A ripe receptacle. Nat. size.
Fig. 520. The same, opened vertically.

so that the mouth becomes turned out as a spreading lip around a cup-shaped cavity (fig. 519). The Carpoboli, containing only one conceptacle, project this with elasticity when ripe. The Nidularini contain many conceptacles lying like eggs in a nest (figs. 519, 520), in *Cyathus* and *Crucibulum* (fig. 521) attached by a funiculus. The structure of the conceptacles is alike in all. The envelope of each is triple (fig. 522); and they form a cavity lined by delicate filaments which converge towards the centre, where

Fig. 521.

Crucibulum vulgare.

A conceptacle detached from the receptacle.

Magnified 12 diams.

Fig. 522.

Cyathus vernicosus.

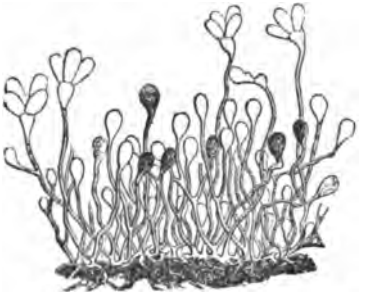
A nearly ripe receptacle, cut open vertically, showing the two halves filled with conceptacles.

Magnified 3 diameters.

their extremities are expanded into *basidia* crowned by four spores (fig. 523), which are cylindrical and almost sessile. The filaments being of very unequal length, the

basidia are intermingled with them in the cavity of the conceptacle, not forming a definitely marked layer.

Fig. 523.



Cyathus striatus.

Basidia and spores from the fertile layer of a conceptacle.

Magnified 250 diameters.

Fig. 524. Fig. 525. Fig. 526.

Cyathus striatus.

Fig. 524. Vertical section of a young receptacle. Magn. 10 diams.
Fig. 525. Another, more advanced. Magn. 10 diams.
Fig. 526. Another, still more advanced. Magn. 5 diams.

Synopsis of British Genera.

* CARPOBOLI. Peridium containing only one conceptacle.

Atractobolus. Perid. simple, cup-shaped, sessile, closed at first by an umbonate lid. Conceptacle spindle-shaped, simple, indehiscent, projected when ripe from the bottom of a peridium.

Thelebolus. Perid. simple, sessile, roundish, urceolate-inflated; mouth entire. Conceptacle globose, papilliform, protruded from the mouth.

Sphærobolus. Perid. double, each layer bursting in a stellate manner, the internal membrane at length turned inside out, and projecting the globular conceptacle elastically.

** NIDULARINI. Peridium with many conceptacles.

Crucibulum. Perid. at first globose-capitate, afterwards crucible-shaped, orifice exposing numerous disk-shaped smooth conceptacles, each with a globular process beneath, prolonged into a long, slender funiculus.

Cyathus. Perid. at first obovate or fusiform, closed by a veil, then widely open at the mouth, exposing ten to eighteen disk-shaped thick conceptacles, umbilicate beneath, and attached to the walls of the peridium by a compound peduncle.

Nidularia. Perid. sessile, subglobose, finally open without evident veil; conceptacles numerous, disk-shaped, nestling in gelatinous mucus, without a funiculus.

BIBL. Tulasne, *Ann. Sc. Nat.* 3 sér. i. 41; Schmitz, *Linnæa*, xvi. 141; Sachs, *Bot. Zeit.* xiii. 823; Pringsheim, *Jahrb.* ii. 199; Eidam, *Cohn. Beit.* ii. 221.

NIPHOB'OLUS, Kaulf.—A genus of Polypodiaceous Ferns, with elegantly articulated veins and numerous naked sori at the tips of free branchlets; under surface with woolly tomentum. = *Polypodium* pt. (Hook. *Syn.* 349).

NIR'MUS, Nitzsch.—A subgenus of *Philopterus*. Like *Docophorus*, but the trabeculæ absent or rudimentary. On the blackcock, grouse, and pigeon.

NITELLA. See CHARACEÆ.

NITOPHYL'LUM, Greville.—A genus of Delesseriaceæ (Florideous Algæ), containing about half-a-dozen British species, only two of which are commonly met with. Their fronds are membranaceous, of reticulated (parenchymatous) structure, mostly rosy red, without ribs, or with irregular ribs towards the base. The membranously expanded frond of *N. punctatum* (Pl. 4. fig. 6), 4 to 12″ high, is either regularly dichotomously divided or parted into two or three principal lobes, which have a border of dichotomous wedge-shaped lobes. *N. laceratum* has the frond 2 to 10″ high, much dichotomously divided and marked with flexuous veins, the segments mostly linear, waved or fringed at the margins. Fructification consisting of spores, tetraspores, and antheridia. 1. Spores sessile on the fronds, arising from tufted filaments contained in *coccidia*; 2. *tetraspores*, forming distinct scattered spots on the frond; 3. *antheridia*, minute cells standing perpendicularly on the surface of the frond, collected into patches, only distinguishable by the help of the microscope.

Bibl. Harvey, *Mar. Alg.* 116, pl. 15 B; *Phyc. Br.*; Greville, *Alg. Br.* pl. 12; Thuret, *Ann. Sc. Nat.* 4 sér. iii. 22.

NITRATE OF POTASH. See Potash, Nitrate of.

NITRIC ACID is useful as a reagent, and for separating the organic matter of the Diatomaceæ from the siliceous valves.

NITZSCH'IA.—A genus of Annulata.

Bibl. Johnst. *Non-parasitic Worms*, 1855.

NITZSCH'IA, Denny (*Liotheum*).—A genus of Anoplura.

N. Burmeisteri is the louse of the common swift (*Cypselus apus*).

Bibl. Denny, *Monogr. Anopl.* 230.

NITZSCH'IA, Hass.—A genus of Diatomaceæ.

Char. Frustules free, single, compressed, usually elongate, straight, arched, or sigmoid, with a longitudinal, not median, external keel (?), and one or more longitudinal rows of puncta; suture in front view of frustules not median.

The valves have no nodules; we have not been able to satisfy ourselves of the presence of the external keel; upon the portions of the valves forming the middle of the side view of the frustules are one or two longitudinal rows of slightly elongate dots or puncta (Pl. 17. fig. 10 *d*), often visible under ordinary illumin.; surface of valves covered with smaller dots, mostly opposite (not quincuncial) (fig. 10 *d*), invisible under ordinary illumination.

The frustules and valves are either linear, lanceolate, or of intermediate forms, sometimes constricted or beaked.

N. sigmoidea (Pl. 17. fig. 9: *a*, side view; *b*, front view); length 1-75″; freshwater.

N. lanceolata (Pl. 17. fig. 10: *a*, front view of frustule; *b*, front view of single valve; *c*, side view of frustule); length 1-150″; fig. 10 *d* exhibits the two kinds of markings as seen with the stops. Marine.

N. birostrata, Sm. (Pl. 17. fig. 11: *a*, side view; *b*, front view); length 1-70″; marine.

N. acicularis (Pl. 17. fig. 13 *b*); length 1-300″; freshwater.

N. reversa (Pl. 17. fig. 12); brackish water.

N. tænia (Pl. 17. fig. 13 *a*); length 1-250″; brackish water.

Bibl. Smith, *Br. Diat.* 37; Hassall, *Algæ*, 435; Rabenh. *Alg.* i. 149.

NOBERT'S LINES and Plates.—These consist of parallel bands or groups of parallel lines, beautifully ruled upon a slide with a diamond. The bands are of equal breadth, and the lines in each successive band are more numerous and closer than in those of the preceding. In the 20-band plate, R. Beck determined the distances of the lines to be as follows, in fractions of an inch.

Band.		Band.	
1.	1-13000th	11.	1-49000th
2.	1-15000th	12.	1-52000th
3.	1-18000th	13.	1-55000th
4.	1-21000th	14.	1-57000th
5.	1-23000th	15.	1-59000th
6.	1-27000th	16.	1-61000th
7.	1-31000th	17.	1-63000th
8.	1-36000th	18.	1-65000th
9.	1-41000th	19.	1-67000th
10.	1-45000th	20.	1-70000th

More recently, a 30-band plate has been produced, in which the lines are ruled to over 1-100,000th of an inch. The exhibition of these lines requires sufficient magnifying power, oblique illumination, and large angular aperture in the object-glass. See Test-Objects. Also Frey, *Mikr.*; Pigott, *Mn. M. Jn.* ix. 63; Robin, *Mic.* 313; Brown, *Pr. Roy. Soc.* xxiii. 531 (*Mn. M. Jn.* xv. 273); Rogers, *Mn. M. Jn.* xvi. 74; Webb, *ibid.* xvi. 171; Beck, *Micr.* 1865, 19.

NOCTILU'CA, Suriray.—A genus of marine Protozoa, now usually referred to the Infusoria.

N. miliaris (Pl. 53. fig. 23) is rounded, of about the size of a pin's head, with a tentacle-like, transversely striated, curved proprocess, by means of which it propels itself through the water. Near its attachment is the mouth, on one side of which is a tooth-like projection. The mouth leads by means of a tubular gullet to an irregular hollow stomach in the sarcode of the interior of the animal; and there is a definite anal opening. The body consists of a radiating protoplasmic network. There is a nucleus; but no vacuoles have been observed. The part to which the tentacle is attached is plicate and depressed, so as to render the body somewhat bilobed; it has no carapace.

Multiplication takes place by subdivision and internal gemmation. Sexual union also takes place, the animals placing their oral apertures close to one another, a protoplasmic bridge being formed, which unites the nuclei of the two individuals; the two Noctilucæ then fuse, and the nuclei become

one. At last a large individual represents the two. Swarm-spores, which become tailed, ciliated, and furnished with the tooth-process, are formed within the conjugated Noctilucæ and escape.

It is phosphorescent, rendering the sea luminous by night; but under the microscope the luminosity does not appear to be uniform, but dependent upon a number of repeated flashes; it is increased by physical and chemical agents.

Bibl. Quatrefages, *Ann. Sc. Nat.* 3 sér. xiv.; Gosse, *Nat. Ramb.*; Krohn, *Wiegmann's Archiv*, 1852; Huxley, *Micr. Jn.* 1855; Brightwell, *Ann. N. H.* 1850, vi. 305; Pring, *Phil. Mag.* 1849; Cienkowski, *Schultze's Archiv*, 1871 & 1872; Carus, *Man. Zool.*; Webb, *Qu. Mc. Jn.* iii.; Busch, *Qu. Mic. Jn.* iii.; Allman, *Qu. Mic. Jn.* 1872, 326; Kent, *Inf.* 397.

NODOSA'RIA, Lamk.—A subgenus of Hyaline Foraminifera. Shell elongate, straight, rounded, conical or cylindrical, with distinct or close-set chambers, smooth, ridged, or spined; orifice terminal, mostly produced and round (*N. raphanus*, Pl. 23. fig. 29). It passes by curvature into *Dentalina* &c., by eccentricity of aperture into *Marginulina* &c., and by compression into *Lingulina* and *Frondicularia*.

Found in Carboniferous and Permian rocks; abundant in the Trias and Lias, and in many strata of later date: living in many seas in rather deep water.

Bibl. D'Orbigny, *For. Foss. Vien.* 38; Williamson, *Rec. For.* 14; Morris, *Cat. Br. Foss.* 37; Parker and Jones, *Ann. N. H.* 3. iii. 478; Carpenter, *For.* 161.

NODOSARI'NA, P. & J.—A genus (strictly a type species) of Hyaline Foraminifera. Its chief subgroups are *Nodosaria* and *Cr. stellaria*, which are one in essential characters of structure and mode of growth: *Glandulina, Lingulina, Dentalina, Rimulina, Vaginulina, Marginulina, Flabellina, Frondicularia*, and others are subsidiary forms. No line of division can be drawn between these approximate allies; for the straight, the curved, and the spiral lose themselves in each other—the amount of curvature and of spirality, and the greater or less closeness of the chambers and of the whorls being varying characters. The style of ornament, chiefly longitudinal ribbings, passing into spines and tubercles, is the same throughout (see Pl. 23. figs. 28 to 39).

Bibl. Parker and Jones, *Ann. N. H.* 3. iii. 477; Carpenter, *Foram.* 159.

NODOSINEL'LA, Brady.—One of the Arenaceous Foraminifera, being a Lituoline isomorph of *Nodosaria*. Fossil in the Carboniferous and Permian rocks. (Brady, *Monogr. Carb. For., Pal. Soc.* 1876.)

NODULA'RIA = *Lemanea*. — Supposed to produce poisonous effects. (Beale, *How, &c.* 281.)

NŒMATE'LIA, Fr.—A genus of Tremellini (Hymenomycetous Fungi) distinguished by the presence of a central nucleus distinguished from the gelatinous surrounding substance. *N. encephala* is common in subalpine countries on larch rails, looking like a small brain, as the name implies.

Bibl. Fr. *Ep.* 591; Berk. *Outl.* 290; Cooke, *Handb.* 350.

NOLEL'LA, Gosse.—A genus of Infundibulate Ctenostomatous Polyzoa, of the family Vesicularidæ.

Distinguished by the erect, subcylindrical cells, crowded on tubes forming an undefined incrusting mat; tentacles eighteen, forming a bell. One species:

N. stipitata.

Bibl. Gosse, *Mar. Zool.* ii. 21.

NONIONI'NA, D'Orb.—A subgenus of Hyaline Foraminifera, subordinate to *Polystomella*. Shell nautiloid, usually symmetrical; many chambers, opening with a transverse slit at the base (*N. crassula*, Pl. 24. fig. 18). By septal modifications it passes into *Polystomella* (*P. striato-punctata*, and *P. crispa*, Pl. 24. figs. 19, 20).

Nonionina is not known for certain in strata older than the Chalk and the Tertiaries. It still abounds in shallow seas of temperate latitudes.

Bibl. D'Orbigny, *For. Foss. Vien.* 109; Parker & Jones, *Ann. N. H.* 3. v. 102; Carpenter, *For.* 286.

NORMANDI'NA, Nyl.—A genus of Pyrenodei (Lichenaceous Lichens).

Char. Thallus squamose, squamulæ thin, rounded; apothecia black, immersed. *N. lætevirens*, green, common on damp earth.

Bibl. Leighton, *Lich. Flora*, 440.

NORMANEL'LA, Brady.—A genus of Copepodous Entomostracea. *N. dubia*, North Sea. (Brady, *Copep.* ii. 87.)

NOSTOC, Vaucher.—The typical genus of the Nostochaceæ, distinguished from the allied genera by the definitely formed hardened pellicle or rind enclosing the fronds, which are composed of a gelatinous substance (fig. 527) in which are imbedded numerous more or less beaded filaments (fig. 528). The filaments are composed of

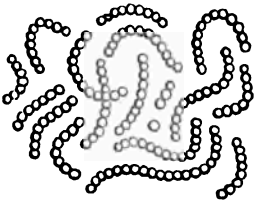
rows of cells (Pl. 8. fig. 7) which increase the length by repeated transverse sub-

Fig. 527.

Nostoc commune.
Natural size.

division; here and there are larger cells (*a, c*) which appear brighter than the rest, resembling the *vesicular cells* of the allied genera. The filaments break up after a time into short fragments, which by cell-

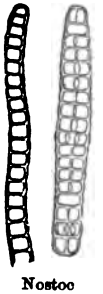
Fig. 528.



Nostoc cæruleum.
Filaments. Magnified 200 diameters.

division produce new filaments. The pellicle of the frond bursts, allowing the gelatinous mass to escape, and the filaments to spread abroad in the water; these consist of short straightish pieces, which move slowly along in the direction of their length; after a time they cease to move, and a new gelatinous envelope is formed around each piece like a transparent sheath. They soon become enlarged considerably, and then divide in the direction of the length of the filament (fig. 529), which becomes so disintegrated that the filament forms a spiral, by the increase of which through further transverse cell-division the mass becomes confused, until the development of a greater quantity of the gelatinous matter makes the filaments more distinct.

Fig. 529.



Nostoc verrucosum.
Filaments multiplying by subdivision.
Magn. 500 diams.

The British species of this genus are found on damp ground, wet rocks, mosses, &c., and free or attached to stones, in fresh water (Pl. 8. fig. 7). They are very numerous, and the following only can be noticed.

* *Frond globose or subglobose.*

Nostoc minutissimum. Frond globose, from 1-30 to 1-4‴; filaments equal, deep æruginous green, densely entangled; periderm growing brown.

N. lichenoides. Fronds from the size of a mustard-seed to that of a pea, aggregated and heaped together; filaments equal, loosely entangled, æruginous or olivaceous; periderm pellucid, colourless, firm.

β. vesicarium; larger, soft, with a fuscous distinct periderm, mucous within, sometimes hollow.

N. sphæricum. Frond the size of a pea, firm, blackish æruginous or somewhat olive-coloured, soft within; filaments pale green, loosely entangled; periderm firm, colourless or fuscescent, subopaque. On stones in mountain rivulets. Meneghini states that, when dried and again moistened, it emits a pleasant odour like violets. Hassall thinks it probably an immature form of *N. foliaceum.*

N. cæruleum. Frond from the size of a pea to that of a sloe, soft and slimy, pale æruginous blue; filaments unequal, loosely entwined, joints oblong-elliptical; periderm colourless, pellucid, soft. On mosses in flowing water or very moist places.

N. pruniforme. Frond the size of a large round plum, deep æruginous green, very soft and watery within; filaments unequal, bright æruginous green, loosely entangled, joints subdepressed, dimidiate; periderm leathery, crystalline; unattached, in fresh-water pools or rivulets.

** *Frond foliaceous, irregular, or vesicular.*

N. foliaceum. Frond terrestrial, membranous, erect, plaited, olive-green; filaments slender, copious. On clayey ground constantly moistened by oozing water.

N. commune (fig. 527, & Pl. 8. fig. 7). Frond terrestrial, gelatinous, subcoriaceous, greenish, irregularly plaited; filaments nearly equal, flexuous, colourless or green, loosely entangled, the joints loosely conjoined, distant or geminate, subspherical, depressed, with a central opaque spot; periderm hyaline, growing brown. Gravelly soils, garden walks, rocks, barren pastures, &c.; very common in autumn and winter.

N. verrucosum, Vaucher. Frond bladder-shaped, softly leathery, fuscous-green; filaments spiral, densely entangled, joints globose; periderm gelatinous, soft, green or dirty brown. On stones in streams.

N. variegatum, Moore.

BIBL. The works above quoted; Itzigsohn, *Bot. Zeit.* xii. 521 (1854); Sachs, *Bot. Zeit.* xiii. 1 (1855); Thuret, *Mém. Société de Cherbourg*, 1857, *Ann. N. H.* 3 ser. ii. 1; Kützing, *Sp. Alg.* 295, and *Phyc. gen.* 204; Fischer, *Nostoc.* 1853; Hicks, *Qu. Mic. Jn.* 1861, ii. 90; De Bary, *Regensb. Fl.* 1863; Rabenh. *Alg.* ii. 161.

NOSTOCHA'CEÆ.—A family of Confervoid Algæ, forming gelatinous strata or definitely shaped gelatinous balls or masses, on damp ground or floating at the bottom of water; consisting of minute, unbranched, usually moniliform, microscopic filaments, tranquil or oscillating, imbedded in a mass of mucilaginous or firmish substance (the amorphous matrix is produced by the fusion of the gelatinous sheaths of the individual filaments); filaments finally breaking up. Cells of the filaments of three kinds:—1. *ordinary* cells; 2. *vesicular* cells or *heterocysts*, usually large and without granular matter, frequently with erect hairs; 3. *sporangia* or *sporangial* cells, produced by the enlargement of the ordinary cells, globular, elliptical or cylindrical. Reproduction by spores has been observed in *Cylindrosperm*um by Thuret, who finds that the *sporangial cells* produce in their interior one thick-coated spore, which, after a season of rest, germinates and breaks out from the sporange to grow into a new cellular filament.

Synopsis of British Genera.

Nostoc. Phycoma globose or spreading, gelatinous or coriaceous, containing simple, curved, and entangled, moniliform, colourless or greenish filaments, composed of cells imbedded in a gelatinous matrix: heterocysts globose, interstitial, larger than the other joints.

Monormia. Frond a gelatinous, elongate, curled and convolute sheath, enclosing a single moniliform filament; heterocysts interstitial; sporangia developed from joints most distant from the vesicular cells.

Trichormus. Heterocysts interstitial and terminal. Sporanges at first formed from the cells most distant from the heterocysts.

Sphærozyga. Heterocysts interstitial; sporanges from the nearest cells.

Cylindrosporum. Heterocysts terminal; sporanges like the last.

Dolichospermum. Heterocysts interstitial; sporanges of unequal length, and without definite arrangement.

Aphanizomenon. Heterocysts none (?); sporanges usually simple and of unequal length.

Spermosira. Heterocysts interstitial, single or in pairs; sporanges as in *Trichormus.*

Exotic genus: *Trichodesmium.*

BIBL. Ralfs, *Ann. N. H.* 2 ser. v. 321; Kütz. *Tab. Phyc.* i. 91; Thuret, *Ann. Sc. Nat.* 2 sér. ii.; Meneghini, *Mem. Turin Acad.* ser. 2. v. 1843; Allman, *Mic. Jn.* 1855; Rabenh. *Alg.* ii. 161; M'Nab, *Qu. Mic. Jn.* 1874, 215; Sachs, *Bot.* 251.

NOTA'MIA, Flem.—A genus of Gemellariidæ, Cheilostomatous Polyzoa.

Char. Cells placed back to back, facing opposite directions; tobacco-pipe-shaped bird's-heads above each pair. One species:

N. bursaria (Pl. 36. fig. 21). An elegant microscopic object.

BIBL. Johnston, *Br. Zooph.* 294; Busk, *Cat. Polyz., Brit. Mus.*, 36; Hincks, *Polyz.* 99.

NOTAS'PIS, Herm.—A genus of Oribatea (Acarina). Cephalothorax with lamellar appendages, tarsi with three homodactyle claws. *N. bipilis*, common in France. (Murray, *Ec. Ent.* 217; Michael, *Jn. Mic. Soc.* 1880, 177.)

NO'TEUS, Ehr.—A genus of Rotatoria, of the family Brachionæa.

Char. Eyes absent, foot forked (=eyeless *Brachionus*).

N. quadricornis (Pl. 44. fig. 13). Carapace suborbicular, depressed, scabrous, areolate, with four spines in front and two behind; freshwater; length 1-10 to 1-70".

BIBL. Ehr. *Infus.* 502; Pritch. *Infus.* 707.

NOTH'RUS, Koch.—A genus of Oribatea (Acarina). Cephalothorax without lamellar appendages, tarsi with three heterodactyle claws. *N. spiniger*, violet-brown, covered with dirt. *N. horridus*, in moss. (Murray, *Ec. Ent.* 219.)

NOTOCHLÆ'NA, Brown.—A genus of Grammitideæ (Polypodiaceous Ferns). Several species; tropical. (Hook. *Syn.* 370.)

NO'TOCHORD.—The new name for the *Chorda dorsalis.*

NOTODEL'PHYS, Allm.—A genus of Copepodous Entomostraca.

N. ascidicola (Pl. 19. fig. 22) resembles *Cyclops* in general appearance. The external ovary is a single organ, lying across the back of the abdomen; eye single; marine.

3 other species.

Bibl. Allman, *Ann. N. H.* xx. 1; Baird, *Br. Entom.* 237; Brady, *Copep.* i. 141.

NOTOD'ROMAS, Lilljeborg.—An Ostracode related to *Candona*, among the *Cypridæ*. It has long setæ on the lower antennæ, and two eyes. Its carapace has a flat ventral surface with limiting ridges; and with this portion upwards it floats at the top of sunny pools in Europe and the British Isles (*N. monachus*, Müller), and in Australia (*N. fenestrata*, King).

Bibl. Brady, *Linn. Tr.* xxvi. 379.

NOTOGO'NIA, Perty.—A genus of Euchlanidota (Rotatoria).

Char. Lorica present, dilated posteriorly, with two pointed processes on each side. Eyes two, red; jaws curved, strong, with two or three teeth; caudal setæ strong; between *Confervæ*.

Bibl. Perty, *Lebensf.* 42.

NOTOM'MATA, Ehr.—A genus of Rotatoria, of the family Hydatinæa.

Char. Free; eye single, cervical; tail-like foot with two toes; rotatory organ simply ciliated.

In some the rotatory organ is extended laterally in an ear- or arm-like form.

Ehrenberg describes twenty-three species, some of which are parasitic, *N. petromyzon* and *parasita* living within *Volvox globator*, and *N. Werneckii* within the vesicles of *Vaucheria*; and divides them into the subgenera:—*Labidodon*, jaws each with a single tooth; *Ctenodon*, jaws each with several teeth.

Notommata granularis is the male of *N. Brachionus*.

Many of the species are large and well adapted for the study of the internal structure.

N. centrura (Pl. 44. fig. 14; 15, jaws and teeth). Body attenuate at each end, foot small and hard; cephalic auricles short; no lateral setæ; freshwater; length 1-36″.

Bibl. Ehr. *Inf.* 424; Duj. *Inf.* 646; Pritchard, *Infus.* 681; Hudson, *M. M. Jn.* 1875.

NOTONEC'TA, L.—A genus of aquatic Hemipterous insects.

The insects belonging to this genus have the elytra membranous in the posterior part, and the body is more or less boat-shaped.

Fig. 530.

Notonecta glauca.
Magnified 3 diameters.

The hind legs are very long, and when stretched out resemble and act as a pair of oars. The *Notonectæ* swim on their backs, and generally in a slightly inclined position, on the surface of ponds and ditches. They descend with great rapidity. They are very voracious, and live on aquatic larvæ, biting also very sharply. Their mouth-organs and limbs afford interesting microscopic objects.

N. glauca (the water-boatman) is common in pools.

NOTOPTEROPH'ORUS, Costa.—A genus of Copepodous Entomostraca. Two species; marine. (Brady, *Copep.* i. 141.)

NUBECULA'RIA, Defrance.—An Imperforate Foraminifer; shell opaque, often sandy, protean, parasitic on shells and algæ; straight, scale-like, or cervicorn; chambers with imperfect base; at first spiral; aperture oval, produced, often lipped. Fossil in the Trias, Oolite, and Tertiaries; common in shallow waters of warm latitudes (*N. rugosa*, Pl. 23. fig. 21).

Bibl. Jones & Parker, *Q. J. Geol. Soc.* xvi. 455; Carpenter, *For.* 69.

NUCLEUS and NUCLEOLUS of Animals. See Cell, p. 138.

NUCLEUS and NUCLEOLUS of Plants.—The term nucleus is applied in botany to two very different things—first to the central body of the young ovules of Flowering plants, and secondly to a peculiar structure met with in the interior of cells. The first will be described under the head of Ovule; the cell-nucleus and nucleolus are treated of in the article Cell, *Vegetable*.

Few parts of the minute organization of plants are more obscure than the structure and function of nuclei: some authors regard them as of the highest physiological importance; others consider their import

altogether unknown. The nucleus may be observed most easily in the parenchymatous cells of the herbaceous structures and flowers of Monocotyledons (Pl. 46. fig. 28 *b*), or in the young cells of the hairs of Flowering plants generally (Pl. 47. figs. 8, 9 *b*), or in the embryo-sacs of ovules (Pl. 47. figs. 4–6); in such cases the characters are well defined and unmistakable. It consists of a lenticular body formed of more or less granular protoplasm, with one or more well- or ill-defined bright points or cavities (*nucleoli*) in the interior. Wherever it appears throughout the higher plants, it seems to possess the same characters; but it may be absent in the cells of many Algæ, Lichens, and Fungi.

Ordinarily nuclei are found attached to the side of cells, or forming the centre of radiating protoplasmic filaments (Pl. 47. fig. 9): sometimes, however, the nucleus is suspended in the middle of the cavity of the cell by filamentous processes of protoplasm; in all such cases it forms a kind of centre for the circulation of the protoplasm where this exhibits movement (Rotation), and it is itself carried about to a certain extent by the currents.

The *nucleoli* (Pl. 47. fig. 8 *n*) of these larger nuclei are apparently usually more or less solid granules of a transparent substance, but sometimes they appear more like minute cavities.

The nuclei and nucleoli of the lower plants are exceedingly obscure; in a great many cases the so-called nuclei are little different from the nucleoli of the larger forms, occupying to the entire cell-contents the same relation as the nucleoli to large nuclei, for example, in the spores of Lichens (Pl. 37. fig. 7), Fungi, &c. In the lower Confervoid Algæ the nucleus (or nucleolus) appears to be represented by the entire cell-contents (Pl. 7), in which one or more well-defined granules often occur, representing nucleoli; in certain stages, however, a larger granule is met with, coloured by chlorophyll, which some regard as a nucleus; this disappears totally at particular epochs, and is replaced by starch-granules or oil-globules. The bright-coloured point, or "eye-spot," seen very generally in the Zoospores both of Confervoids and Fucoids, may represent a nucleolus.

Nuclei originate in two ways. The simplest mode is found where they precede free-cell formation, as in the development of the germinal vesicles in the embryo-sacs of Flowering plants. Here the nuclei appear first as globular, granular, or lenticular masses, which become gradually defined in the substance of a collection of protoplasm accumulated at the upper end of the cell (Pl. 47. figs. 1–4). This is a spontaneous isolation of a portion of the protoplasm to become the foundation of a new cell. We may compare this with the segmentation of the entire mass of contents of the cells of Confervæ in the formation of Zoospores, which may perhaps be regarded as at first free *nuclei*. In cells multiplying by division, a division of existing nuclei has been observed to take place in certain cases, as in the hairs of *Tradescantia* (Pl. 47. figs. 8 & 9); but in other similar cases of division no nuclei are observed (Pl. 47. figs. 10 & 11). In *Tradescantia*, the oval parent nucleus fills up the end of the growing cell, so that the division of the nucleus is almost synonymous with the division of the primordial utricle. But in this case, as in the development of cells from free nuclei, as indicated in the germinal vesicles, the cell-membrane in expanding draws away from the nucleus, which remains adherent to or suspended in connexion with a layer of protoplasm lining the cell-wall and forming its primordial utricle. In Spirogyra and *Zygnema*, a division of the free suspended nucleus precedes the division of the large primordial utricle.

Mohl describes a division of nuclei as occurring in *Anthoceros*; and most authors who have written on the development of pollen and spores lay great stress on the influence of the nuclei, which they describe; but the import of nuclei in vegetable cells is certainly still a problem. Some believe they are the universal agents of production of new cells; others that they are not the agents of this in any case, but, when present, may be divided with the cells. Others imagine that they are merely the original "mould" of protoplasm on which the cellulose membrane of the nascent cell is deposited, and which is left unaltered when this expands (the phenomena in *Spirogyra* are opposed to this). Some of those who deny their influence in cell-development believe them to be the vital centres of the cells in which they exist.

They are best seen in very young cells in all cases; in nascent tissues they almost or quite fill the cavity of the young cells. As the cells grow older, their history differs in different cases. Sometimes they persist

until the decay of the organ in which they exist. This happens very generally in the cells of the flowers, stems, &c. of Monocotyledons; not unfrequently, in stems and leaves they become converted into starch or chlorophyll granules. In other cases they have a more definite purpose; for in the vesicles in which are formed the SPERMATOZOIDS of Ferns, Mosses, Hepaticæ, Characeæ, &c., these structures appear to be produced by a metamorphosis of the nuclei.

In examining supposed nuclei of plants, especially those of lower cellular organization, tincture of iodine should always be applied, to distinguish starch-granules &c. from true nuclei, which are always coloured deep yellow or brownish by that reagent, besides being coagulated, contracted, and thereby rendered more distinct.

BIBL. R. Brown, *Phil. Mag.* Dec. 1831; Nägeli, *Zeit. wiss. Bot.* (*Ray Soc.* 1845 & 1849); Mohl, *Pflanzenzelle*, 36, 51; Hofmeister, *Entsteh. d. Embryo*, 1849, 7; Braun, *Verjüngung* (*Ray Soc.* 1853, 175); Sachs, *Bot.* 45; Strassburger, *Zellenbildung*, 1880.

NUMMULI'NA, D'Orb. } A Hyaline Fo-
NUMMULI'TES, Lamk. } raminifer of the highest class. Shell lenticular, varying in convexity and in size (from less than $\frac{1}{10}$ to 2½ inches in diameter), composed of several, overlapping, uniform, whorls of numerous >-shaped chambers in a discoid spire. These are prolonged towards the umbo of each face, thus forming Alar Lobes, either straight (in the *Radiatæ*), or sinuous (*Sinuatæ*), or inosculating (*Reticulatæ*). The alæ are abortive or absent, and the spire therefore exposed, in *Assilina* and *Operculina*, unequal and modified in *Amphistegina*. The chambers communicate by a transverse slit at the base of the septum, with smaller occasional holes. The outer chamber-walls (Spiral Lamina) are thin in the latest, but in the older chambers thickened by successive layers of the delicate tubuliferous shell. Over the septa of the median plane (Pl. 24. fig. 22), and where the alar septa cross and touch, the tubuli being obsolete, the shell becomes translucent (Pillars); at the outer margin (Marginal Cord) also of the whorls the layers of shell become translucent, and are traversed by radiating and inosculating tubes, continuous with canals passing between the two shell-layers of each septum (Interseptal Canals), and with the canals in the margin of the inner whorls. This Canal-system carries spiral and branching threads of sarcode through the denser parts of the shell, which, indeed, in some *Polystomellæ* and *Calcarinæ* appear to be secreted thereby (Supplementary Skeleton).

Nummulina is rare in the Carboniferous, Jurassic, and Cretaceous, but very common in the Lower Tertiary strata; living in the North, Red, and Australian seas, but small (*N. radiata*, Pl. 24. fig. 21).

BIBL. D'Archiac et Haime, *An. foss. Num. Inde*, 1853; Carter, *Ann. N. H.* ser. 2. xi. 161, ser. 3. viii. 320, 366; Parker and Jones, *Ann. N. H.* ser. 3. v. 106, viii. p. 229; Carpenter, *Foram.* 262, *Microscope*, 1858, 510; Brady, *Ann. N. H.* ser. 4. xiii. 222.

NYCTOTHE'RUS, Leidy.—A genus of Heterotrichous Infusoria, very near *Plagiotoma*. 4 species; in the intestines of Amphibia and Invertebrata. (Kent, *Inf.* 579.)

NYMPHÆACEÆ. See HAIRS (p. 379).

O.

OAT, *Avena sativa* (Nat. Order Graminaceæ, Flowering Plants).—The form of the starch-corpuscles of the oat is very unlike that of the other common corn-plants; they consist of numerous small polygonal grains grouped together in roundish or oval masses (Pl. 46. fig. 10). See STARCH.

OBE'LIA = *Laomedea* pt.

OBISIDA. See ARACHNIDA.

OBJECT-GLASS, or OBJECTIVE. See INTRODUCTION, p. xvi. & ANGULAR APERTURE, p. 47.

OCEL'LI.—The simple eyes or eye-spots of the Invertebrata; they are noticed under the classes.

OCHLOCHÆTE, Thwaites.—A genus of Chætophoraceæ. *O. hystrix*, on grasses in freshwater and brackish ditches.

OCHROPTE'RIS, Sm.—A genus of Pteridеæ (Polypodiaceous Ferns). *O. pallens*; Mauritius. (Hook. *Syn.* 127.)

OCTAVIA'NA, Tul.—A genus of Gasteromycetous Fungi (section Hypogæi) distinguished by the sterile base of the continuous or cracked peridium; the easily divisible byssoid frames and the fruit-bearing cavities at first empty, then covered with the rough spores.

BIBL. Tul. *Fung. Hyp.* t. ii. f. 1; Berk. *Outl.* 292; Cooke, *Handb.* 355.

OCTOSPORES.—Sporangia of Fucaceæ, which subdivide into a cluster of eight cells.

ODONTEL'LA, Ag. — This genus of Diatomaceæ is united with BIDDULPHIA, *Biddulphia* (*Odontella*) *aurita* undergoing spontaneous division, Pl. 19. fig. 9.

ODONTHA'LIA, Lyngb.—A genus of Rhodomelaceæ (Florideous Algæ) containing one British species, *O. dentata* (Pl. 4. fig. 13), which has an irregularly bipinnatifid frond, 3 to 12″ long, the main axis and lobes 1-4″ wide throughout; colour deep wine-red, darker when dried. Frond with marginal, stalked, ostiolate, ovate *ceramidia* with spores, lanceolate *stichidia*, in which are contained two rows of ternate tetraspores, and *antheridia*.

Bibl. Harv. *Alg.* 77, pl. 11 A; *Phyc. Br.* pl. 34; Greville, *Alg. Br.* pl. 13, Kütz. *Phyc. generalis*, 448.

ODONTID'IUM, Kütz. — A genus of Diatomaceæ.

Char. Frustules quadrangular, united into an elongated biconvex filament; linear in front view; valves elliptical with transverse continuous striæ. Freshwater and marine.

Differs from *Denticula* in the elongated filament, which sometimes, however, consists of only three or four frustules!

O. turgidulum (Pl. 17. fig. 14: *a*, front view; *b*, side view). Valves lanceolate, obtusish; striæ on each valve six; freshwater; length of frustules 1-1720 to 1-570″.

O. tabellaria, Smith = *Staurosira construens*, Ehr. (Pl. 50. fig. 38).

Bibl. Kütz. *Bacill.* p. 44; *Sp. Alg.* p. 12; Smith, *Brit. Diat.* ii. 15; Rabenh. *Fl. Eur. Alg.* i. 116.

ODONTODIS'CUS, Ehr.—A genus of Diatomaceæ. See Coscinodiscus.

Char. Frustules single, lenticular; valves circular, alike, without nodules, covered with dots arranged either in radiating rows or in excentrically curved lines, and with erect marginal teeth. Three species; fossil and in guano.

O. eccentricus (Pl. 18. fig. 52).

Bibl. Ehr. *Ber. Berl. Ak.* 1844, 73; Kütz. *Sp. Alg.* 129; Pritchard, *Infus.*

ODON'TOPHORE. — A new name for the tongue of the Mollusca; and Radula is another.

ODONTOTRE'MA, Nyl.—A genus of Lecideinei (Lichenaceous Lichens).

Char. Thallus indistinct. Apothecia black, thelotremoideo-lecideine or gymnotremoid, naked, at first closed, then dehiscing with a denticulato-ruptured proper margin.

O. longius, Nyl. On old rails.

Bibl. Leighton, *Lich. Flora*, 389.

ŒCIS'TES, Ehr.—A genus of Rotatoria, of the family Œcistina.

Char. Single; rotatory organ single, with an entire margin; body attached to the bottom of a fixed cylindrical carapace; eyes two, frontal, red, disappearing in advanced age.

O. crystallinus (Pl. 44. fig. 16). Carapace hyaline, viscid, covered with foreign bodies; freshwater; entire length 1-36″.

Jaws each with three teeth.

Bibl. Ehr. *Inf.* 392; Pritchard, *Inf.*; Davis, *Mic. Tr.* 1866, 14; Hudson, *Jn. M. Soc.* 1881, 1.

ŒCIS'TINA, Ehr.—A family of Rotatoria (small *Melicertæ*, probably).

Char. Animals single or aggregate, attached to the bottom of a gelatinous carapace; rotatory organ single, with an entire margin.

A distinct carapace for each animal... 1. *Œcistes.*
Carapaces aggregated into a sphere... 2. *Conochilus.*

Bibl. Ehr. *Infus.* 391.

ŒDE'MIUM, Fr.—A genus of Dematiei (Hyphomycetous Fungi). *Œ. atrum*, Corda, consists of dense tufts of brown erect fibres, scarcely branched, and without true septa. The roundish "spores" are sessile upon the sides of the erect filaments.

Bibl. Corda, *Sturm's Deutschl. Fl.* 6, pl. 9; Fries, *Syst. Myc.* 344; Berkeley and Broome, *Ann. N. H.* 2 ser. vi. 466.

ŒDIPO'DIUM, Schwägr.—A genus of Splachnaceæ (Acrocarpous Mosses), sometimes included under *Gymnostomum*. *Œdipodium Griffithianum*, Schwäg., the only species, is remarkable for the peculiarly thickened fruit-stalk, whence the name of the genus is derived.

ŒDOGONIA'CEÆ.—A family of filamentous Confervoid Algæ, remarkable for the filaments growing by a peculiar mode of cell-division, accompanied by circumscissile dehiscence of the parent cell, and by the zoospores being formed from the whole contents and bearing a crown of numerous cilia. Two genera:

Œdogonium. Filaments unbranched.

Bulbochæte. Filaments branched and bearing bristle-cells with a bulbous base.

Bibl. See the genera.

ŒDOGO'NIUM, Link. (*Prolifera*, Leclerc, *Vesiculifera*, Hass.).—A genus of Œdogoniaceæ (Confervoid Algæ). Some *Œdogonia* are among the commonest and most abundant of freshwater Algæ, occurring in every pond, ditch, or stream, and quickly making their appearance in tanks, aquaria, &c. They may generally be recognized at a glance by the dense and uniform green protoplasm, sometimes filling the cells, sometimes (after dividing) leaving half of the

cell colourless and devoid of chlorophyll—above all, by the annular striæ occurring at the ends of many of the cells (Pl. 9. fig. 7 *b*, *h*). The cells have each a large parietal nucleus (fig. 7 *a*). The large round interstitial sporangial cell (fig. 7 *g*) is also a very distinctive character. The filaments are attached, when young, to stones, plants, &c. by root-like processes; and are composed of rows of cylindrical cells, which multiply interstitially in a very curious manner. When a cell is about to divide, an annular deposit of cellulose occurs around the upper part of the parent cell. Next the wall of the parent cell breaks, by a circumscissile dehiscence, just below the cellulose ring. The internal cell elongates and removes the margins of the circular slits from each other, the upper piece of the parent-cell wall being pushed up as a kind of cap on the elongating cell. While the cell is thus being elongated, its primordial utricle becomes divided below the line of dehiscence of the parent cell; but both the new portions grow, so that the line of division between the two new cells at length rises above the margin of the lower part of the parent cell. The annular deposit of gelatinous cellulose has meanwhile become stretched or developed over the space left by the separation of the halves of the parent membrane, forming an outer coat to the new cell. After the growth of the lower cell is finished, the upper one begins to elongate, until it attains equal length; it remains poor in protoplasm and chlorophyll while growing, but becomes densely filled when it has attained its full dimensions. The margins or broken ends of the parent-cell wall form the annular striæ seen on the filaments (Pl. 9. fig. 7 *b*, *g*, *h*): at first there is only one at the top of any given cell; but the next dehiscence takes place just below this, giving rise to a second, and so on, until many successive rings are produced at one spot.

The zoospores or ciliated gonidia (fig. 7 *c*) are formed from the entire contents of a cell, and exhibit a large round nucleus; they escape by a circumscissile dehiscence of the wall of the parent cell (*b*): the filament, however, does not generally become quite broken in two; the portions remain attached by a strip of the side-wall forming a kind of hinge; and the zoospores are not set free directly, but at first are enclosed in a very delicate and almost imperceptible globular envelope, colorable blue by iodine and sulphuric acid, which appears to dissolve very quickly in the water. The zoospores are large, somewhat ovate in form, with a transparent region at one end, whence the numerous cilia arise. When expelled, they move for a time, and then come to rest, attaching themselves to foreign objects by the ciliated end, acquiring a membrane, sending out root-like processes below (*e*), and elongating and expanding above into a longish pear-shaped body. Sometimes the zoospores do not completely extricate themselves from the parent cell, and then germinate in this way *in situ*, the root-like processes remaining engaged in the parent cell. Very often they attach themselves upon the parent filament to germinate. The next stage after germination presents two different classes of phenomena: in the one case, as a purely vegetative zoospore, the young plant elongates gradually into a jointed filament by extension and cell-division; in the other it is an *androspore*, and becomes an *antheridial* filament.

The *Œdogonia* produce large resting-spores (oospores or oogonia), which are formed from the entire contents of the uppermost of two cells developed as above described. A rupture of the parent-cell wall takes place at the side during the development of the spores; through the small orifice thus formed the spore-mass becomes fertilized through the agency of the little globular bodies produced in the antheridia (Pl. 5. figs. 5, 16, 17). Ultimately the spore, while increasing in size, retracts itself from the walls of its parent cell (*oogonium*), and lies free in the cavity, presenting a double coat, the outer of which is thick and tough; its contents acquire a red colour as it ripens. The parent cell of the spore mostly acquires a globular or elliptical form, and a red or brown colour, appearing like a kind of nodule on the filament; and the ripe spore, of globular elliptical, or depressed spherical form, is mostly of greater diameter than the ordinary cells (Pl. 5. fig. 21). The ripe spore, which is quadruple, escapes by the decomposition or dehiscence of the parent cell, and is covered with a hyaline membrane. Each of the four spores is likewise surrounded by its cell-membrane. After a short time has elapsed, the hyaline membrane disappears, and the four spores lie still and motionless. Then a change sets in: the cell-membrane of each spore bursts by means of an annular slit, and a part separates like a lid. Soon the cell-contents leave the cell in the form

of a zoospore, which moves with the aid of a crown of cilia. After a time the motion ceases, the cilia disappear, and one end of the zoospore becomes elongated into a root like the ordinary zoospores. The little cell thus fixed becomes divided by a transverse septum. Each spore thus produces four *Œdogonium* plants.

The antheridial structures of the *Œdogonia* are either formed in the ordinary filaments (Pl. 5. fig. 13), or from dwarf filaments produced from the smaller zoospores or *androspores* (Pl. 5. fig. 19). In either case they consist of one or more very short joints of the filament, formed in the ordinary way, the contents of which divide into two portions. The cells then dehisce and allow the new products to escape, which resemble the vegetative zoospores, but are much smaller. These new bodies, the spermatozoids, make their way through the orifices in the parent cells of the spores and fertilize their contents (Pl. 5. fig. 20).

Some of the larger spermatozoids move like *Amœbæ*, creeping over the oospore, until they reach the canal, into which they enter.

The *Œdogonia* appear to be sometimes purely monœcious or dicœcious, the single filaments including either both antheridial and spore-cells, or only one kind of organ; but the most common condition is intermediate: the filaments having some joints converted into sporangial cells, others giving birth to the androspores, which germinate into dwarf antheridial filaments, often sessile on or near the sporanges, which produce spermatozoids. This condition is termed by Pringsheim *gynandrosporous*.

The systematic arrangement of the species is difficult on account of the variability in the size of the filaments. Pringsheim makes the following arrangement:—

* *Spores globular.*

† *Sporanges opening by a valvular lid.*

Œ. rostellatum. Sporange oval, spore globular, not filling the sporange. Antheridia 3- or 4-celled. Monœcious.

†† *Sporanges opening by a lateral orifice.*

‡ *Monœcious.*

Œ. curvum. Sporanges depressed, orifice in the middle line; spores completely filling the sporanges, and of the same form. Antheridia 3- and 4-celled.

Œ. tumidulum. Sporange ovate, orifice in the upper half; spore globular, not filling the sporange. Antheridia mostly 2-celled.

‡‡ *Gynandrosporous.*

Œ. Rothii. Dwarf male plant straight, sessile on the sporange, without a spreading base. Sporange ovate, expanded in the middle; orifice in the middle line; spores depressed, filling the inflated part of the sporange.

Œ. depressum. Male plant straight, sessile on the sporange, with a foot and internal 1-celled antheridia. Sporange depressed, orifice in the middle line; spores of the form of the sporange, not filling it.

Œ. Braunii. Male plant curved, with a foot and 1-celled antheridium. Sporange oval, inflated in the middle; spore globular, not filling the sporange.

Œ. echinospermum. Male plant almost straight, sessile on the cell below the sporange, with foot and outer 1-celled antheridium. Sporange oval, orifice in the lower half; spore globular, spinous.

** *Spores oval.*

† *Sporanges opening by a circular lid.*

‡ *Gynandrosporous.*

Œ. ciliatum. Male curved, sessile on the sporange, with foot and outer 1-celled sporangium. Spores oval, filling the broken portion of the sporange.

†† *Sporanges opening by a lateral orifice.*

‡ *Gynandrosporous.*

Œ. apophysatum. Male plant curved, sessile below the sporange, and outer 2-ranked antheridium. Sporange oval, orifice in the upper half; spore filling the sporange up to the cap-like part.

‡‡ *Dicœcious.*

Œ. gemelliparium. Male plants more slender than the female; antheridia many-rowed; septa of the parent cells perpendicular to the other cell-septa. Sporange oval, orifice in the upper half, the spore filling it completely to the cap-portion. Filaments ending in several almost hyaline elongated cells, without a terminal bristle.

BIBL. Mohl, *Bot. Zeit.* xiii. 689; De Bary, *Soc. Sc. Nat. Fribourg*, 1856; Carter, *Ann. N. H.* 3 ser. i. 29; Hassall, *Alg.* 195; Braun, *Kütz. Sp. Alg.*; Rabenh. *Alg.* iii. 347; Juranyi, *Pringsheim's Jahrb.* 1873; Prings-

heim, *Jahrb.* i. 1; De Bary, *Ann. Sc. N.* 4 sér. v. 262; Sachs, *Bot.* 281.

OID'IUM, Link (*Acrosporium* and *Sporotrichum*, Greville; *Torula*, Corda).—A supposed genus of Mucedines (Hyphomycetous Fungi), but very probably consisting of imperfect conditions of plants of more complex nature. The *Oidia* have recently attracted great attention on account of the extraordinary development of the form called *Oidium Tuckeri* on the vines of Europe and the Atlantic islands. This, however, like *O. leucoconium* and others, appears to be only the conidiiferous mycelium of an ERYSIPHE or some allied plant; the particulars of its history are given more at length under VINE-FUNGUS. *Oidium lactis* seems also referable to *Torula*, or to the mycelium of PENICILLIUM. *O. abortifaciens*, Lk., is an imperfect state of CLAVICEPS; *O. albicans*, Robin, the fungus of APHTHA, is probably referable to some other genus when mature, as *Achorion* should perhaps also be included under *Penicillium*. The objects described as *Oidia* consist of delicate horizontal filaments, creeping over leaves, fruits, or decaying vegetable and animal substances (*O. lactis* at the edges of sour milk, *O. albicans* in the mouth of the human subject), forming an interlaced fleecy coat, the horizontal filaments giving origin to numerous erect, usually short, articulated pedicels, the uppermost cells of which (or several of the uppermost) expand into oval bodies (*conidia*) which become disarticulated, and, falling upon the matrix, germinate and produce new filaments (Pl. 26. figs. 8–11).

Oidium leucoconium, Tuckeri, erysiphoides are white; *O. aureum, fulvum, fructigenum*, and others subsequently become coloured, and these certainly belong to a different category.

BIBL. Berk. *Hook. Br. Fl.* ii. pt. 2. 349; *Ann. N. H.* i. 263, vi. 438, 2 ser. vii. 178, xiii. 463; *Crypt. Bot.* 300, 308; Fries, *Sum. Veg.* 494; Fresenius, *Beitr. z. Mycol.* H. i. 23, ii. 76; Léveillé, *Ann. Sc. Nat.* 3 sér. xv. 109; Grev., *Crypt. Fl.* pl. 73; Robin, *Végét. Par.* 2nd ed. 488; and the *Bibl.* of VINE-FUNGUS.

OIKOM'ONAS, Kt.—A genus of Flagellate Infusoria. Exceedingly minute, ovate, flagellum single; a thread-like process protruded at will from the posterior part of the body, serving for attachment. Six species; in infusions, fresh- and salt-water. (Kent, *Inf.* 250).

OIL.—Oils of various kinds are most abundantly produced by a very large number of plants, and occur to some extent in almost all. For the microscopist, it is convenient to divide them into *essential* and *fixed* oils. The former are special secretions, and occur in the cells of the GLANDS and Glandular HAIRS of the epidermis of those parts of plants exposed to the air and light. Fixed oils are found principally in the cells of tissues still physiologically active in the nutrition of the plants, and they appear in many cases to have a close relation with and to form substitutes for starch. Thus fixed oils occur stored up in the cells of the perisperms or of the cotyledons of certain seeds in which little or no starch is produced, as in the *Papaveraceæ, Cruciferæ, Linum*, the almond, nut, &c. Oil may occur also in the pulp of fruits, as in the olive.

SPORES of Cryptogamic plants and POLLEN-grains are remarkable for the oil they exhibit in their mature condition. It appears to serve as an indifferent or inert form of assimilated nutriment.

Oil occurs in the cavity of cells in the form of minute drops, which may be distinguished mostly, by the experienced microscopist, by simple inspection; but it is often desirable to prove the nature of the globules, which may be done by removing them with benzole, or, in the case of pollen, by viewing them in spirit of turpentine or oil of lemon.

OI'THONA, Baird.—A genus of Copepodous Entomostraca. *O. spiniferus*; marine. (Brady, *Copep., Ray Soc.* i. 90.)

OLEAN'DRA, Cav.—A genus of Aspidieæ (Polypodiaceous Ferns). 6 species; tropical. (Hook. *Syn.* 302.)

OL'IGOCLASE. See ROCKS.

OLPID'IUM, Braun.—Like *Chytridium*, but without operculum or rootlet, elongated into a cylindrical tube; epi- or entophytic, on freshwater Algæ; *O. simulans*, in the living leaves of the dandelion. (Rabenhorst, *Alg.* iii. 282.)

OMPHALOPEL'TA, Ehr.—A genus of fossil Diatomaceæ which agrees with *Actinoptychus*.

O. areolata (Pl. 18. fig. 53).

BIBL. Ehr. *Ber. Berl. Ak.* 1844, 263; Kütz. *Sp. Alg.* 132; Grev. *Mic. Tr.* 1866, 122.

ONCOBRY'SA, Agardh (*Hydrococcus*, Kütz.).—A genus of Palmellaceæ. Fronds minute, hardish; cells in rows, the super-

ficial ones crowded, forming a cortical layer. 3 species, brownish-green or purplish; on submersed wood and mosses. (Rabenh. *Alg.* ii. 67.)

ONCOSPHE'NIA, Ehr.—A genus of Diatomaceæ.

O. carpathica. Valves laxly striated, one end turgid, rounded, and straight; the other attenuate and uncinate; freshwater; diam. 1-790″.

Bibl. Ehr. *Ber. Berl. Ak.* 1845, 72; Kütz. *Sp. Alg.* 11; Rabenh. *Alg.* i. 296.

ONION, *Allium Cepa* (Flowering Plants, Nat. Ord. Liliaceæ).—The young bulb of the onion offers a very good and cheap subject for the investigation of the development of spiral vessels, to those who do not object to its odour; other bulbs will do equally well. In the cells of the base of the bulb occur very elegant groups of prismatic crystals (see Raphides).

ONOCLEA, Sw.—A genus of Dicksonieæ (Polypodiaceous Ferns). Sori dorsal, globose, on the veins of changed contracted pinnæ of the fertile fronds, and concealed by their revolute margins. 3 species; cold or temperate climates. (Hook. *Syn.* 45.)

ONYCH'IUM, Kaulf.—A genus of Pteridæ (Polypodiaceous Ferns). Four species; tropical. (Hook. *Syn.* 143.)

ONYCHODROMUS, Stein.—A genus of Hypotrichous Infusoria. Like *Stylonichia*, but the ventral styles linear, and the caudal setæ absent. *O. grandis*; freshwater. (Kent, *Inf.* 706.)

ONYGE'NEI.—A family of Ascomycetous Fungi, containing a few inconspicuous plants growing upon the feathers of dead birds, or upon cast-off hoofs and horns. The flocculent spreading mycelium usually produces on its surface little white stalk-like bodies crowned by a globular perithecium. At first erect and thick, these supports become more slender as they elongate, and seem to bend under the weight of the light perithecium (fig. 531). In some species the perithecium is sessile. The perithecium is filled with branching filaments, arising from the walls of its internal cavity, interlacing together and bearing at their free extremities globular cells (*asci*) containing the spores (figs. 533, 535). At the epoch of maturity the perithecium, originally closed, bursts circularly towards the base, the upper part becoming detached under the form of a more or less regular cap (fig. 532), exposing the spores set free by a solution of the filaments.

Fig. 531. Fig. 532.

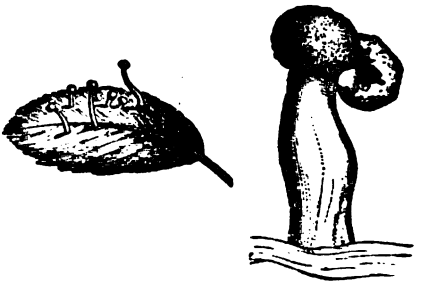


Fig. 533. Fig. 534.

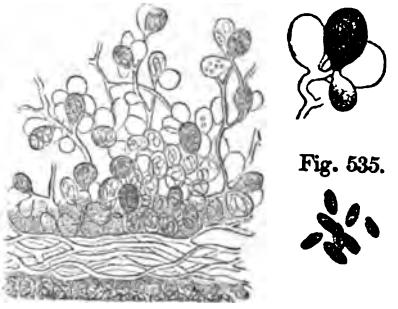


Fig. 535.

Onygena corvina.

Fig. 531. Plants on a feather. Nat. size.
Fig. 532. Single plant with the perithecium dehiscing. Magn. 10 diams.
Fig. 533. Portion of the sporiferous layer, with asci. Magn. 350 diams.
Fig. 534. Asci detached. Magn. 700 diams.
Fig. 535. Spores. Mag. 700 diams.

British Genus.

Onygena. Perithecium capitate, at length slit round the base, and falling off as an imperforate cap. Asci borne at the free ends of filaments forming an entangled mass in the perithecium, finally free and pulveraceous.

Bibl. Berk. *Br. Fl.* ii. pt. 2. 322; *Ann. N. H.* vi. 432, 2nd ser. vii. 184; Tulasne, *Ann. Sc. Nat.* 3 sér. i. 367, pl. 17; Greville, *Crypt. Fl.* pl. 343; Cooke, *Handb.* 641.

OOCAR'DIUM, Näg., = *Inomeria.*

OOCYS'TIS, Näg.—A genus of Palmellaceous Algæ, probably identical with *Nephrocytium.*

Bibl. Rabenh. *Fl. Eur. Alg.* iii. 52.

OOGO'NIUM.—A term sometimes used to signify the parent cell of a true female spore.

OOLITE, or ROESTONE, is the substance of oolitic rocks, and consists of carbonate of lime, partly crystallized, partly granular; the granules usually include organic remains, as broken shell, &c. It consists of two parts, one of which, forming the matrix, is mostly colourless, often crystalline, and exhibits a number of round or oval cavities, each of which contains a nodular granule of a corresponding form. The nodules are sometimes coloured, rarely hollow, and often exhibit concentric rings like those of calculi, and indicative of the successive deposition of layers. Sometimes a Foraminifer, but more often an organic fragment, or grain of sand, forms the nucleus of the grain.

Polished sections of oolite form interesting objects; and where the nodules are coloured and the matrix colourless, as in oolite from Bristol, in which the former are red, the beauty of the appearance is increased.

See ROCKS.

OOMY'CES, Berk. and Br.—A genus of Pyrenomycetes (Ascomycetous Fungi), founded on a minute plant growing upon the leaves of grasses. *O. carneo-albus*, (*Sphæria carneo-alba*, Libert) has pale, flesh-coloured, tough receptacles 1-18″ high, marked with the ostioles of 3-7 perithecia closely packed within it, bearing resemblance to the eggs of some insects.

BIBL. Berk. and Broome, *Ann. Nat. Hist.* 2 ser. vii. p. 185.

OOSPORE.—A term used to indicate a spore which is impregnated before germination, as in *Œdogonium*; and also applied to the larger form of spore in SELAGINELLA and ISOËTES.

OPAL.—A siliceous mineral. There are many varieties, thin sections of which present interesting objects for the microscope and microspectroscope. Wood opal is wood petrified with hydrated silica, and is light and not very hard. It exhibits in some places vegetable structure. Other opals contain the remains of substances which may be of vegetable origin, or of minerals which simulate such organisms.

BIBL. Dana, *Mineral.*; Slack, *M. Mic. Jn.* 1873, 105; Zirkel, *Mineral.* &c. 112.

See AGATE.

OPALI'NA, Purk. and Val.—The animals comprised under this title were formerly regarded as Infusoria; but later researches tend to show that many are imperfectly developed forms or intermediate stages of higher animals. They are microscopic, oval or oblong, colourless, covered with vibratile cilia arranged in regular rows. Some contain a nucleus, and exhibit contractile vesicles; but they do not admit colouring-matters, nor have they a mouth. In one form an adhesive suctorial disk has been observed, and in another a hook-apparatus, probably serving the same end. They are parasitic within the bodies, usually the intestinal canal, of earth-worms, frogs, *Planariæ*, *Naides*, beneath the gill-plates of *Gammarus*, &c.

O. (*Bursaria*, F.) *ranarum*, is figured in Pl. 31. fig. 47.

BIBL. Purkinje and Valentin, *De mot. vibr.*; Schultze, *Turbell.*; Stein, *Inf.*; Claparède et Lachmann, *Études*, 373; Lankester, *Qu. M. Jn.* 1870, 143; Kent, *Inf.* 558.

OPEG'RAPHA, Ach.—A genus of Graphideæ (Lichenaceous Lichens), growing on bark of trees, stones, &c. Besides their linear *lirellæ*, the fronds bear *spermogonia*, in *O. varia* and *O. calcarea* forming black spots on the surface, communicating with little unilocular cavities lined with short linear sterigmata bearing numerous spermatia. Several species.

BIBL. *Br. Fl.* ii. pt. 1. 147; Tulasne, *Ann. Sci. Nat.* 3 sér. xvii. 207; Leighton, *Lich. Flora*, 395.

OPERCULAREL'LA, Hincks,= *Campanularia* pt. (Hincks, *Hyd. Zooph.* 193.)

OPERCULA'RIA, Goldfuss.—A doubtful genus of Vorticellina, now included in *Epistylis*.

O. articulata, E. Found adherent to *Hydrophilus piceus* and *Dytiscus marginalis*. Pl. 32. fig. 25.

O. berberina, St. Found upon *Noterus crassicornis*, a water-beetle.

Other species, on Entomostraca, &c.

BIBL. Ehr. *Infus.* 286; Stein, *Infus.*; Claparède et Lachmann, *Études*, 111; Kent, *Inf.* 710.

OPERCULI'NA, D'Orb.—A Nummuline Foraminifer. Shell flat, discoidal, many-chambered; spire exposed, and whorls rapidly increasing in width. The shell-structure of *O. arabica*, Carter, is described at p. 330 (Pl. 24. figs. 23-26), Rare in the Chalk, and abundant in many Tertiary beds. Large and plentiful in the East-Indian and South seas; common, but small, in the northern seas.

BIBL. Williamson, *Tr. Micr. S.* ii. 159 ("*Nonionina*"); Carter, *Ann. N. H.* 2. x. 161, 3. viii. 311; Carpenter, *Phil. Tr.* 1859;

For. 247; Parker and Jones, *Ann. N. H.* 3. viii. 229.

OPHIDOM'ONAS, Ehr.—A generic name applied to slender, filiform, spiral (helical), *Vibrio*-like bodies, of a brown or red colour, with obtuse ends, and actively moving through the water by means of an anterior flagelliform filament. Ehrenberg places them among the Infusoria, in the family Cryptomonadina, and admits two species, characterized by the difference in colour. One was found in fresh, the other in brackish water. Length about 1-570″, breadth 1-9000″. In some the spire forms only half a turn, in others two and a half turns.

Probably an Alga. Is it the young state of *Spirulina*?

Bibl. Ehr. *Infus.* 43, and *Ber. Berl. Ak.* 1840; Kent, *Inf.* 244.

OPHI'OCLES, Hincks.—A genus of Hydroid Zoophytes.

Char. Stem branching, rooted by a creeping stolon, capsules vase-shaped; polypes not retractile; body deeply constricted a little below the base of the tentacles, which surround a conical proboscis. Tentaculoid organs borne on the stem and stolon, highly extensile. Reproduction by fixed spore-sacs.

Bibl. Hincks, *Brit. Hyd. Zooph.* 230.

OPHIOCY'TIUM, Näg.—A genus of Unicellular Algæ.

Char. Cells free, single, vermiculate, obtuse at one end, mucronate at the other.

O. majus (Pl. 5. fig. 11), on freshwater plants.

Bibl. Rabenh. *Alg.* iii. 66.

OPHIO'DES, Murr.—A genus of Ixodea (Acarina). Body thin, flat, circular; on foreign snakes. (Murray, *Ec. Ent.* 203.)

OPHIO'DES, Hincks.—A genus of Hydroid Zoophytes. *O mirabilis*, on *Laminaria* &c. (Hincks, *Zooph.* 230).

OPHIOGLOSSA'CEÆ.—An Order of Ferns, distinguished from all others by the characters both of the vegetative and reproductive structures. Fronds divided into two parts, one foliaceous and sterile, the other fertile, neither being rolled up in the form of a crook. Sporanges destitute of annulus, and split transversely nearly to the base.

Ophioglossum. Sporangia sessile, in two rows, forming a narrow spike.

Helminthostachys. Sporangia in crested clusters, forming a long loose spike.

Botrychium. Sporangia sessile, in two rows on the spikes which form a panicle.

OPHIOGLOS'SUM, Linn.—The typical genus of Ophioglossaceous Ferns, represented by the Adder's-tongue Fern, *Ophioglossum vulgatum.* Other tropical species. (Hook. *Syn.* 444.)

OPHIONEL'LA, Kt.—A genus of Peritrichous Infusoria. Solitary, elongate, pesistome as in *Vorticella*; contained in a soft sheath. *O. picta*; freshwater. (Kent, *Inf.* 734.)

OPHIOTHE'CA, Curr.—A genus of Myxogastrous Fungi, distinguished by a simple peridium bursting longitudinally; capillitium twofold, viz. hyaline articulated threads, to which the spores are attached, and echinulate thicker branched filaments.

O. chrysosperma occurs on the inner bark of dead trees.

Bibl. Curr. *Qu. Mic. Jn.* ii. 240; Berk. *Outl.* 310; Cook, *Handb.* 402.

OPHRYDI'NA, Ehr.—A doubtful family of Infusoria, corresponding to Vorticellina with a carapace.

Animals grouped in a gelatinous mass ... *Ophrydium.*			
Animals single.	Body attached to the bottom of the carapace by a stalk...		*Tintinnus.*
	Body not stalked.	Carapace stalked ...	*Cothurnia.*
		Carapace sessile ...	*Vaginicola.*

Bibl. Ehr. *Infus.* 291; Clap. et Lach. *Etudes*, 93.

OPHRYD'IUM, Ehr.—A genus of Peritrichous Infusoria, family Vorticellina.

Char. Consists of a colourless, gelatinous, rounded mass, either adherent or free, containing numerous greenish *Vorticella*-like animals imbedded and somewhat radiately arranged within it; freshwater. Length of extended bodies 1-100″; size of entire mass from that of a pea to that of the fist, and even more.

O. versatile (Pl. 31. fig. 49, portion near the surface; fig. 48, portion expanded by pressure; fig. 50, separate animal). The gelatinous mass or envelope has been described as consisting of separate portions or cells, and again as forming a homogeneous whole. It somewhat resembles and has been mistaken for frog's spawn. The body exhibits annular constrictions and longitudinal folds, and contains scattered chlorophyll-granules, and a long, narrow, tortuous nucleus. A distinct narrow elongated œsophagus is present. Ehrenberg remarks that at first the individual bodies are united in the centre by filaments, which subsequently disappear. The animals undergo

the encysting process; when they leave the jelly, a posterior ring of cilia is formed, as in *Vorticella*, and the animals swim with the tail first.

This organism bears some resemblance to *Coccochloris* among the Palmellaceæ, yet it appears decidedly animal.

O. Eichornii, on *Anacharis*.

Bibl. Ehr. *Infus.* 292 ; Stein, *Inf.*; Claparède et Lachmann, *Etudes*; Kent, *Inf.* 735.

OPHRYOCERCI'NA, Ehr.—A family of Infusoria. See Trachelina.

OPHRYODEN'DRON, Clap. et Lach.—A genus of Acinetina.

Char. Acinetina with the suckers attached to a long retractile proboscis.

Six species; marine.

O. abietinum, on *Campanularia*.

Bibl. Clap. et Lach. *Etudes*, 381; Kent, *Inf.* 849.

OPHRYOGLE'NA, Ehr.—A genus of Holotrichous Infusoria, of the family Bursarina.

Char. Ovate; a frontal eye-spot; cilia in longitudinal rows; a watch-glass-shaped vibratile membrane near the mouth. Freshwater.

Five species. Stein remarks that, on treating these animals with acetic acid, the cilia became converted into a dense network of curved and geniculate hairs, some as long as the body.

O. atra (Pl. 31. fig. 51). Body ovate, compressed, black, acute posteriorly; eye-spot black, marginal; cilia whitish; length 1-180″.

O. acuminata, brown; eye-spot red.

O. flavicans, yellowish; eye-spot red.

Bibl. Ehr. *Inf.* 360; Stein, *Inf.* 240; Duj. *Inf.* 506; Lieberkühn, *Ann. N. H.* 1856, xviii. 319; Claparède et Lachmann, *Etudes*, 256; Kent, *Inf.* 532.

OPHRYOSCO'LEX, St.—A genus of Peritrichous Infusoria. Free, ovate-elongate, with a *Vorticella*-like peristome; middle of the back surrounded by a row of stout setæ; a long posterior style-like process. 2 species; in the rumen and reticulum of ruminants. (Kent, *Inf.* 652.)

OPISTHIOT'RICHA, Perty.—A genus of Infusoria.

Char. Small, cylindrical or pyriform. Cilia on body fine, those on posterior part large. *O. tenuis*, in bog-pools.

Bibl.. Perty, *Lebensf.* 150.

OPIS'THODON, Stein.—A genus of Hypotrichous Infusoria. Free, ovate, dorsally convex, vertically plane, ciliate; mouth near the posterior half, with a cylindrical rod-fascicle. *O. niemeccensis*; freshwater. (Kent, *Inf.* 749.)

OPISTHOTRICH'IA, Kt.—A genus of Hypotrichous Infusoria. Free, ovate; frontal, ventral, and anal styles as in *Oxytricha*, also with caudal setæ. 2 species; freshwater. (Kent, *Inf.* 785.)

ORBICULI'NA, Lamk.—A genus of porcellaneous Foraminifera. Discoidal, equilateral, greatly compressed, very variable according to age; forming an embracing, very regular spire when young, subsequently growing into a more or less perfect disk, almost undistinguishable from *Orbitolites*. Chambers very narrow, curved, and divided throughout their length into numerous minute cavities (chamberlets) by perpendicular partitions, transverse to the spiral coil. Orifices very numerous, round, in rows along the septal plane on the outer margin of the shell.

Living in tropical seas (*O. adunca*, Pl. 23. fig. 19); fossil in the Tertiaries.

Bibl. Carpenter, *Phil. Tr.* 1856, 547; *For.* 93.

ORBITOI'DES, D'Orb.—One of the hyaline Foraminifera, related to *Nummulites* and often mistaken for it. Lenticular; thick or thin; smooth, granular, or radiate; composed of a median plane of chamberlets arranged cyclically, and of very numerous layers of compressed chamberlets above and below.

Fossil only; in the Upper Chalk, and Lower and Middle Tertiaries.

Bibl. Gümbel, *Abh. bayer. Ak.* 1868, x. 670.

ORBITOLI'NA. See Patellina and Porosphæra.

ORBITOLI'TES, Lamarck (*Orbulites*).—A porcellaneous Foraminifer, near *Orbiculina*, but distinguished by the chambers being arranged in concentric circles.

Inhabiting tropical seas.

O. complanatus (Pl. 23. fig. 17) = *Sorites* and *Amphisorus*, Ehr.; fossil in the Lias, Chalk, and Tertiaries.

Bibl. Morris, *Brit. Foss.* 39; Carpenter, *Phil. Tr.* 1856, 181; *For.* 105.

ORBULI'NA, D'Orb.—A hyaline Foraminifer, consisting either of a single spherical chamber, or of a large globular chamber enclosing a small Globigerine group of earlier cells. Perforations numerous, minute and of two sizes; but single orifice doubtful. *O. universa* (Pl. 24. fig. 1). Recent, and fossil as far back as the Lias.

Bibl. D'Orbigny, *For. Vien.* 22; Williamson, *Rec. For.* 2; Carpenter, *For.* 176; Alcock, *Mem. Lit. Phil. Manch.* 3. iii. 178; S. Owen, *J. Linn. Soc. Zool.* ix. 149; Terquem, *Mém. Metz*, 1862, 432; Brady, *Qu. Mic. Jn.* n. s. xix. 75.

ORGANIZATION AND VASCULARIZATION.—Immediate reunion of cut surfaces may take place without any exudation; but in healing by what is termed the first intention, a substance is present which glues the edges of the wound together. This consists of the connective tissue of the cut surface, infiltrated with blood-corpuscles and serum, and swollen by the imbibition of the latter. The next stage of the process is the migration of colourless corpuscles from the dilated vessels in the immediate neighbourhood. They permeate the whole of the cementing medium and the adjacent connective tissue, so that the divided parts are at length united by a continuous layer of embryonic tissue. The next step is the reestablishment of the circulation. Thiersch found the cut ends of the vessels a few hours after the injury plugged by a corpuscular proliferation and somewhat dilated, but seldom occupied by a blood-clot. Injecting the vessels at this stage with a warm solution of gelatin, and hardening the specimen in alcohol, he found sticking to the surface of the club-shaped plug of gelatin, endothelial cells, some detached and isolated, others undergoing proliferation. Moreover he found a peculiar configuration of the surface of the plug, in which were the radicles of a very beautiful system of intercellular canals, forming a provisional nutrient apparatus. The last act is the transformation of that part of the embryonic tissue which is not employed in the construction of vessels, into fibrous connective tissue. Should pus be formed in a wound, healing by the second intention occurs (see Pus). Pus is given off from the wound, and from its surface young cells force their way from countless points; they are accompanied by a fluid mainly transmitted from the blood, and very rich in dissolved albuminous matters. Sooner or later the cells close up their ranks, and a layer of embryonic tissue is formed, which intervenes between the parenchyma of the organism on the one hand and the pus on the other. Then this embryonal connective tissue gets thicker, rises into small globular projections or granulations; they produce both skin and cuticle, and new vessels. Along certain lines running through the parenchyma in which these new vessels are to be, a closer aggregation of the cells becomes apparent; a cord or row of cells becomes visible, pointing out the form and direction of the future blood-path. Soon the blood makes its appearance in the axis of the cellular cord, and the cells parted asunder begin to constitute the wall of a new blood-vessel. As each layer of embryonal tissue is formed on the surface, rows of cells aggregate as above, and new vessels are completed. As the cicatrical tissue contracts after its formation out of the embryonal tissue, and as it is fashioned at the deepest part of the wound, first the whole of the raw surface shrinks and compresses the vessels, obliterat ting many and reducing the vascularity of the healing tissues.

ORIB'ATA, Latr.—A genus of Oribatidæ, of which there are several species, on stones and plants. Some are common.

The position of three species is doubtful, viz. *Acarus confervæ*, Schr., freshwater, creeping upon Confervæ, &c.; *Oribata demersa*, Duj., with a cervical eye, upon *Hypnum inundatum*; and *Oribata marina*, a marine species.

Bibl. Gervais, *Walck. Apt.* iii. 251; Schrank, *Ins. Austriæ*, 511; Dujardin, *L'Instit.* 1842, 316; Koch, *Deutschl. Crust.*; Dugès, *Ann. Sc. Nat.* 2. sér. ii. 46; Murray, *Ec. Ent.* 217.

ORIBA'TEA.—A family of Acarina.

Char. Body covered by a hard horny dark envelope; palpi fusiform, 5-jointed; first joint small, second large, inflated and almost half the length of the entire palpus, palpi hairy outside only; mandibles chelate; body often winged; no suckers. Genera:

Nothrus. Body elongate, irregularly quadrilateral, with spinous filaments; legs of moderate length, thick, tarsi with 3 homodactyle claws.

Belba. Abdomen distinct from thorax, rounded, inflated; legs long, geniculate, with 1 claw.

Oribata. Cephalothorax with lamellar appendages; tarsi with 3 heterodactyle claws; hairs bristle-shaped.

Cepheus. Cephalothorax lamellar; claws 3, alike.

Notaspis. Cephalothorax lamellar, tectum confounded with it.

Leiosoma. Cephalothorax with plates, claws 3, heterodactyle.

Pelops. Like *Oribata*, but hairs flat and spatula-shaped.

Hermannia. Cephalothorax soldered to abdomen; tarsi with 1 claw.

Eremæus. Cephalothorax simple; tarsi with 3 heterodactyle claws.

Damæus. Cephalothorax ribbed, legs longer than the body, 1 claw.

Galumna. Abdomen subglobular, depressed, margins of the pseudothorax winged; legs of moderate length.

Hoplophora. As the last, but wing-like appendages absent; tarsi 1-clawed.

BIBL. *Walckenaer's Aptères*, 251; Koch, *Deutschl. Crustac.*; Dugès, *Ann. Sc. Nat.* ii. 48; Dufour, *Ann. Sc. Nat.* 1 sér. xxv. 289; Nicolet, *Archiv d. Muséum*, 1855; Michael, *M. M. S.* 1879, 225, 1880, 32, 177.

ORNITHO'BIUS, Denny.—A genus of Anoplura. Like *Nirmus*, but with 2 horns to the clypeus. *O. cygni*, on the swan; 2 other species.

OROBIAS, D'Eichwald.—A Nummuline or Fusuline Foraminifer, found in the Carboniferous Limestone of Russia; possibly a true *Nummulina*.

BIBL. D'Eichwald, *Leth. Ross.* i. 352.

ORTHOCERI'NA, D'Orb.—A Stichostegian Foraminifer, related to *Nodosarina*; square or triangular in cross section; without septal furrows; orifice terminal, simple or pouting.

Recent in W. Indies, *O. quadrilatera* (Pl. 23. fig. 36); fossil in the Tertiary, Chalk, Gault, and Oxford Clay.

BIBL. Carpenter, *For.* 166.

ORTHOCLASE. See ROCKS.

ORTHODON'TIUM, Schwägr., = *Bryum* pt. *O. gracile*, on sandstone rocks. (Wilson, *Bryol. Brit.* 218.)

ORTHOP'TERA.—An order of Insects, containing the grasshoppers, crickets, &c.

ORTHOSI'RA, Thw. See MELOSIRA.

ORTHOTRICHA'CEÆ.—A tribe of Pottioid Mosses including several British genera.

a. Papillæ distinct, tuberculate, rarely obsolete: peristome mostly pale, rarely orange-coloured.

Zygodon. Calyptra dimidiate. Peristome wanting, simple, external or internal, more rarely glabrous. without an annulus.

Orthotrichum. Calyptra campanulate, plaited. Peristome absent, simple, or double. External of thirty-two geminate (sixteen, fig. 483) or bigeminate (eight, fig. 537) teeth, more rarely of sixteen entire, undivided teeth, granular, fleshy or brittle, mostly pale, rarely orange-coloured, erect, afterwards reflexed, arising below the mouth of the capsule. Internal: eight or sixteen cilia, simple, hyaline, or rarely resembling the teeth. Vaginule ochraceous. Inflorescence monœcious or dioecious. Capsule without an annulus, pyriform, grooved, rarely glabrous; operculum capitate, conical.

b. Papillæ mostly obsolete, rarely distinct; peristome always coloured, purple, red, or orange.

Glyphomitrium. Calyptra campanulate, large, totally enclosing the capsule, deeply laciniate, plaited. Peristome of sixteen short, lanceolate, densely trabeculate, entire teeth, with a central line, in pairs, incurved, arising below the orifice, orange-coloured, smooth (fig. 283, p. 360). Inflorescence monœcious.

Brachystelium. Calyptra as in the preceding, entirely or almost covering the capsule, mitre-shaped, with long and repeated laciniations, slightly plaited. Peristome as in *Trichostomum*, the teeth more or less split to the base into two arms. Inflorescence monœcious.

Guembelia. Calyptra dimidiate, otherwise like the following (figs. 289–291, p. 366).

Grimmia. Calyptra mitre-shaped, laciniate, smooth, scarcely exceeding the operculum, or shorter. Peristome simple, teeth sixteen, lanceolate, with a median line, trabeculate; often, however, fissile, hence very polymorphous, more or less split as far as the middle into two or four teeth, or into two arms down to the base (fig. 288, p. 365).

Fig. 536. Fig. 537.

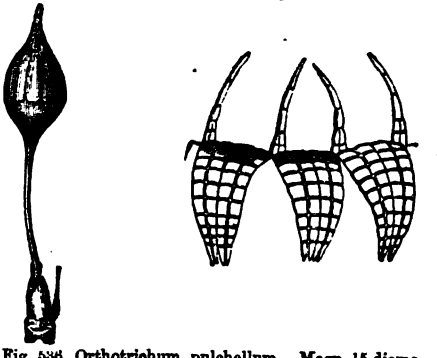


Fig. 536. Orthotrichum pulchellum. Magn. 15 diams.
Fig. 537. Orthotrichum pallens. Fragment of peristome. Magn. 50 diams.

ORTHOT'RICHUM, Hedwig.—A genus of Orthotrichaceæ (Pottioid Mosses), growing in round tufts, fertile at the summit, on

trees and stones, never on the earth. British species numerous, remarkable for the apophyses, sometimes having stomata, and the varied character of the outer peristome, the thirty-two teeth of which are variously conjoined, so as to appear thirty-two, sixteen, or eight. Calyptra mostly covered with hair-like processes (fig. 472, p. 512).

Bibl. Wilson, *Bryol. Br.* 185; Hooker, *Br. Fl.* ii. pt. 1. 57; Venturi, *M. M. Jn.* 1881, 80.

OSCILLATO'RIA, Vauch.—A genus of Oscillatoriaceæ (Confervoid Algæ), distinguished from the allied forms by the simple, rigid, elastic filaments, forming a stratum in a common gelatinous matrix. Filaments enclosed singly in tubular cellulose sheaths, open at the ends, from which the fragments emerge when broken across (Pl. 8. fig. 8). The young filaments or growing extremities are continuous and scarcely striated; but by degrees transverse striæ appear, sometimes very close together, sometimes distant, indicating a constriction and final fission in the substance of the filament, which, when old, readily breaks at these places. The internal structure of the filament is obscure: it seems to be composed wholly of protoplasmic substance, the joints not possessing special cellulose coats; but the substance of the filament, although apparently solid, seems sometimes less dense internally, since we have noticed a kind of hour-glass contraction intermediate between the striæ after the action of thick syrup (by endosmose) and after desiccation. The curious rounding-off of the separated ends of dividing filaments (Pl. 8. fig. 8, right-hand figures) seems to depend on some power of expansion of an outer thicker layer of the substance of the filament. The motion of the filaments will be described under Oscillatoriaceæ. The filaments ultimately break up at the striæ into distinct joints, which may be regarded as *gonidia*. No formation of spores has been observed. A remarkable and unexplained appearance is occasionally observed at the growing ends of the filaments: they appear crowned by a wreath of cilia; but these processes are rigid and motionless.

The species occur on damp ground, on stones, mud, in fresh water, running or stagnant, in springs, and in brackish water; a few are truly marine. In the following characters the colour of the strata is given as seen by the naked eye, that of the filaments as seen under the microscope.

* In fresh water, or on damp earth, &c.

a. Stratum æruginous or blue-green.

O. limosa, Ag. Stratum dark green, glossy, with long rays; filaments green, 1-3300 to 1-3600″ in diameter; articulations shorter than the diameter. At the bottom of ditches and pools.

O. tenuis, Ag. Stratum dark green, thin, with short rays; filaments pale green, 1-4200″ in diameter; articulations equalling or half the diameter. In muddy ditches, &c.; at first on the bottom, finally floating.

O. muscorum, Ag. Stratum dark æruginous-green, 3 or 4″ in extent, growing over mosses in rapid streams; filaments thickish, pale blue-green.

O. turfosa, Carm. Stratum pale verdigris-green, glaucous, 1 or 1½′ in diameter, resting on an ochraceous substratum; filaments hyaline, very slender. On floating sods in turf-pits.

O. decorticans, Grev. Stratum smooth, glaucous-green, membranous, peeling off in flakes; filaments pale bluish green, very slender. Damp walls, pumps, &c.; common.

b. Stratum dull green, inclining to purple, black, or brown.

O. nigra, Vauch. Stratum blackish green (bluish black when dry), with long radii; filaments pale bluish green, 1-2800 to 1-3000″ in diameter; joints equalling or a little shorter than the diameter. Ditches and ponds. Common.

O. autumnalis, Ag. (Pl. 8. fig. 8). Stratum purplish or greenish black; filaments pale dirty bluish green, 1-4000 to 1-5000″ in diameter; joints shorter than the diameter. Damp ground, walls, &c. Common.

O. contexta, Carm. Stratum glossy black, spreading three feet or more, appearing satiny and striated to the naked eye; filaments pale green, 1-3000″ in diameter; articulations largish. On mud; apparently common.

O. ochracea, Grev., is probably the same as *Leptothrix ochracea*.

** Marine, or in brackish water.

O. littoralis, Carm. Stratum bright æruginous-green; filaments deep green, thicker than in *O. nigra*; joints one third the diameter. Pools on the sea-shore. See Symploca.

Bibl. Harvey, *Br. Alg.* 1st ed. 161; *Mar. Alg.* 228; *Phyc. Brit.* pls. 105, 251;

Hassall, *Alg.* 244, pls. 70–72; Kütz. *Sp. Alg.* 237; *Tab. Phyc.* Bd. i. pls. 38–44; Rabenh. *Alg.* ii. 95; Engelmann, *Beweg. Bot. Zeit.* 1879.

OSCILLATORIA'CEÆ.—A family of Confervoid Algæ, containing organisms of considerable diversity and not well characterized at present, owing to the obscurity of the reproduction. The genus *Oscillatoria*, with its nearest allies, is composed of cylindrical filaments of protoplasmic substance, invested by a continuous cellulose sheath or tubular cell-membrane. The internal (solid ?) filament gradually becomes transversely striated as it increases in age, and subsequently breaks across at the transverse lines; and the fragments readily escape from the sheaths, since no cross walls of cellulose are produced (Pl. 8. fig. 8). These kinds exhibit clearly the remarkable motion from which the family takes its name. They are mostly found upon damp ground, forming wide and irregular strata. *Rivularia* and the allied genera have the joints of the filaments more distinct; and the filaments are coherent into definite fronds, on which they stand erect or radiate from a centre (Pl. 8. figs. 13, 16). The sheaths often become complicated, from the internal multiplication and the persistence of the cellulose sheaths of several generations one within another (see PETALONEMA), often gelatinously swollen up, and sometimes decomposed into spiral fibrous structures (Pl. 8. fig. 15; see SPIRAL STRUCTURES). Some of the remaining forms differ considerably from the above, and are imperfectly understood. *Spirulina* (Pl. 7. fig. 15) has the filaments curled spirally; and in the strange plant *Didymohelix* (Pl. 1. fig. 10) two spiral filaments occur twined together. These last minute forms generally occur imbedded in a gelatinous stratum.

The structure of the Oscillatoriaceæ, judging from *Oscillatoria*, *Microcoleus*, and *Lyngbya*, differs importantly from that of all other Confervoids. The filaments are not composed of rows of cells, but, in the earliest condition, of a cylindrical thread of protoplasm, coloured greyish, green, brown, or purple in different cases. The ends of the growing filaments are narrower and devoid of striæ, and have no perceptible cellulose sheath; when a little older, cross striæ appear, consisting of double rows of granules or dots, and the tubular cellulose coat is evident; finally the striæ become distinct lines (see Pl. 8. figs. 8–22). In this stage, external violence will cause the filament to break across at the striæ; and the fragments then slide along inside the cellulose sheath, the broken ends always assuming a rounded form like that of the free extremities (Pl. 8. fig. 8 *b*). When these fragments slide quite out of the sheaths, the latter appear as continuous tubes (Pl. 8. fig. 8 *a*), seldom with any cross markings opposite the striæ of the internal mass. In *Lyngbya* the division seems to take place in a peculiar manner, accompanied by an interstitial growth comparable to that of ZYGNEMA. In a well-developed filament, every eighth stria is strongest, the intermediate fourths rather lighter, every second one between them paler still, and the intermediates of these only just marked; while in *Oscillatoria* the striæ seem to be gradually less definite towards the growing apex of a filament. The filaments appear solid as ordinarily viewed; but the endosmose resulting from placing them in syrup or gum-water causes them to contract between the striæ, or to break up into lenticular disks. The ultimate fate of all the filaments seems to be a separation into disks or globular gonidia, by breaking across at the striæ.

In *Microcoleus* (Pl. 8. fig. 9) and many *Rivulariæ* there would appear to be a transverse multiplication like that occurring occasionally in NOSTOC, as the filaments are found lying side by side in gelatinously decomposed outer (parent) sheaths. The filaments of the *Rivulariæ* are seated on a large basal cell (Pl. 8. figs. 13, 16, 18), the nature of which is not understood.

The remarkable spontaneous motion of many Oscillatoriaceæ presents a considerable variety of conditions. In *Oscillatoria* and *Microcoleus* the ends of the filaments emerge from their sheaths, the young extremities being apparently devoid of this coat; their ends wave backwards and forwards, somewhat as the fore part of the bodies of certain caterpillars are waved when they stand on their prolegs with the head reared up. This motion probably depends upon the irregular contraction of different parts of the protoplasm. The filaments also emerge from the tubes and break up; and the fragments then exhibit an oscillating movement like that of a balance, together with an advance in a longitudinal direction. *Lyngbya* (Pl. 8. fig. 10) does not appear to oscillate, at all events when in long filaments; *Spirulina* and other forms exhibit only a tremulous oscillation; *Didymohelix* probably ac-

quires its double-spiral character from the entwining of originally distinct filaments. *Leptothrix* and the allied genera are very imperfectly known, and are only included here from the absence of indications of closer affinities elsewhere; very likely they are mycelial filaments of Fungi.

These plants occur on damp ground, rocks, or stones, and among Mosses and other Confervæ on rocks, stones, &c. in fresh and salt water, and are allied in some respects to the NOSTOCHACEÆ; but the articulations of the filaments of the latter are all perfect cells with a complete cellulose wall, multiplying by division in the same way as the Confervaceæ.

Synopsis of British Genera.

A. *Oscillatorieæ.* Filaments transversely striated or moniliform, sometimes spirally curled; sheathed, or, in the minute forms, without evident sheaths; exhibiting spontaneous oscillating or creeping motion. Increased by transverse division.

Didymohelix (Pl. 1. fig. 10). Filaments brown, very slender, continuous, curled spirally and twisted together in pairs. No evident sheaths, but a common investing jelly.

Oscillatoria (Pl. 8. fig. 8). Filaments coloured, continuous, transversely striated, readily breaking across, with a proper cellulose sheath, oscillating; collected in strata and imbedded in a common gelatinous matrix.

Microcoleus (Pl. 8. fig. 9). Filaments as in *Oscillatoria*, but collected into bundles in a common gelatinous dichotomously branched tubular sheath; filaments oscillating.

Cœnocoleus. Filaments branched, annulated, contained with their ramifications within a tough, more or less permanent sheath which bursts irregularly.

Symploca. Filaments as in *Oscillatoria*, but erect and tufted, coherent at their bases, bristling above.

B. *Lyngbyeæ.* Filaments motionless (?), oscillarioid, enclosed in a very distinct sheath, tufted, or forming strata, with or without an enveloping jelly.

Dasyglœa (Pl. 8. fig. 11). Filaments unbranched, sheathed; older sheaths broad, coalescent outside into an amorphous gelatinous stratum.

Lyngbya (Pl. 8. fig. 10). Filaments elongated, distinctly articulated, unbranched, with distinct convoluted cellulose tube, but without a gelatinous matrix (motion creeping?); articulations very close.

Liebleinia. Filaments short, erect, tufted, unbranched, with distinct cellulose coat, free, without an investing jelly.

Chamæsiphon. Crenothrix.

C. *Scytonemeæ.* Filaments distinctly articulated, simple or branched, motionless, with distinct articulations and large interstitial (propagative?) cells; sheaths at length softened and swollen, but without a common gelatinous matrix.

Scytonema (Pl. 8. fig. 19). Filaments cæspitose, or more rarely fasciculate, with a double (lamellar) gelatinous sheath, (mostly) closed at the apex; branches continuous by lateral growing out of the primary filaments, with a knee-like base.

Desmonema. Filaments branched, more or less coherent; branches of two kinds, primary branches each with a connecting cell at the base, secondary branches without connecting cells; annulated. See TOLYPOTHRIX.

Arthronema (Pl. 8. fig. 20). Filaments distinctly articulated, simple, in short lengths, overlapping at their ends within the gelatinous sheath.

Petalonema (Pl. 8. fig. 21). Filaments branched, with the outer sheaths of the single joints expanded upwards and outwards into funnel-shaped bodies, each partly overlapping its successor, forming a common obliquely lamellated and transversely barred gelatinous cylinder.

Calothrix (Pl. 8. fig. 22). Filaments very closely articulated, tufted, with branches in apposition for some distance, here and there cohering laterally. Sheaths firm, often dark-coloured.

Tolypothrix. Filaments free, radiantly or fastigiately branched, most distinctly articulated at the bases of the branches; branches continuously excurrent, not in apposition; sheaths thin, hyaline.

Sirosiphon. Filaments single, double or triple, within a distinct common sheath, very distinctly articulated; branched by lateral budding, the branches divergent.

Schizothrix (Pl. 8. fig. 17). Filaments branched by division; sheaths lamellated, thick, rigid, curled, thickened below, finally longitudinally divided.

Symphyosiphon. Filaments erect or as-

cending, enclosed in lamellated, hard sheaths, concreted laterally at their bases, involved in jelly.

Rhizonema. Sheath cellular and furnished throughout its length with numerous branched and anastomosing rootlets (?). Filaments distinctly annulated, and interrupted here and there by a connecting cell. Branches in pairs, arising from a protrusion of the filament.

Fischera.

D. *Rivularieæ.* Filaments distinctly articulated, with an enlarged basal cell, mostly attenuated above, connected into definite or indefinite fronds; motionless.

Schizosiphon (Pl. 8. fig. 13). Basal cells globose, filaments simple, distinctly articulated, mostly attenuated towards the apex, sheathed, sheaths connate into groups, hard, dark-coloured, open and expanded above, and overlapping so as to form a succession of ochreæ which have the free borders slit up into filaments or fringes; also displaying a spiral fibrous structure in dissolution.

Physactis. Filaments whip-shaped, torulose at the base, sheathed, sheaths simple, gelatinous, collected into a globose and solid, or subsequently a bullose-vesicular frond; in the globose fronds the filaments radiate from the centre, in the vesicular fronds from the internal or lower surface of the gelatinous matrix.

Ainactis (Pl. 8. fig. 15). Filaments branched, jointed, with thin sheaths, collected into a solid pulvinate frond, concentrically zoned by the dichotomous branching of the filaments. Sheaths more or less solidified by carbonate of lime; sometimes exhibiting a spiral structure in dissolution.

Rivularia (Pl. 8. fig. 18). Filaments with an oval basal cell succeeded by one of cylindrical form (*manubrium*), the remainder short, attenuated in diameter upwards (whip-shaped); sheaths sometimes saccate below, open (not fringed) above; forming a slippery gelatinous frond.

Euactis (Pl. 8. fig. 16). Filaments whip-shaped, with repeated ochreate sheaths, forming fronds in which they radiate, and by superposition of successive generations form concentric layers; sheaths cartilaginous, lamellated, firmly united laterally, dilated upwards (funnel-shaped), decomposed into a fringe at the orifice.

Inomeria. Filaments whip-shaped, vertical, parallel; sheaths obscure, everywhere decomposed into very slender filaments; forming crustaceous fronds, becoming stony.

Petronema. Densely cæspitose, erect, somewhat regularly branched; branches free, with obtuse rounded apices, and each with a connecting cell at the base. Filaments annulated and growing thicker upwards.

E. *Leptotricheæ.* Doubtful Oscillatoriaceæ.

Leptothrix. Filaments very slender, neither branched, articulated, concreted, nor sheathed.

Hypheothrix. Filaments unbranched, inarticulate, sheathed, interwoven into a more or less compact stratum.

Symploca. Filaments unbranched, inarticulate, sheathed, concreted into branches, conjoined at their bases; sheath a simple hyaline membrane.

OSMIC ACID.—An oxide of the metal osmium, obtained from platinum-ores. It is a crystalline, volatile, poisonous substance, soluble in water, with a powerfully irritating odour. Its aqueous solution is used for hardening and colouring certain animal tissues black or dark blue, as fat-cells and globules, the medulla of nerves, more slowly the ganglion-cells, the connective-tissue corpuscles, Zoophytes, &c. The ordinary strength is about 90 grains to a pint. Small pieces of the structures should be immersed in it, from ¼ hour to 24 hours, then well-washed in distilled water, and mounted in acetate of potash or Farrant's compound. It is also useful for its remarkable power of killing Infusoria, Rotatoria, &c. so suddenly, that the cilia remain extended, instead of being retracted and undistinguishable as with other reagents. (Ranvier, *Hist. techn.*; Robin, *Micr.* 220; Frey, *Mikr.*)

OSMO'SIS. See ENDOSMOSE.

OSMUN'DA, Linn.—A genus of Osmundaceous Ferns, represented in Britain by *Osmunda regalis* (figs. 222, 223, p. 319), the Royal or Flowering Fern, as it is termed, a large and handsome plant, found in damp situations; not common.

OSMUNDA'CEÆ.—An order of Polypodiaceous Ferns, characterized by the broad imperfect annulus on the back of the sporanges. Genera:

Osmunda. Sporangia on metamorphosed pinnules.

Todea. Sporangia on unchanged pinnules.

OSTRACO'DA. See ENTOMOSTRACA.

OTOGLE'NA, Ehr.—A genus of Rotatoria, of the family Hydatinæa.

Char. Eyes three; one sessile and cervical, the two others stalked and frontal; neither jaws nor teeth present.

O. papillosa. Body campanulate, turgid, rough with papillæ; freshwater; length 1-96″.

Bibl. Ehr. *Inf.* 453; Pritchard, *Inf.* 690.

OTOLITHS.—The crystalline or crystalloid particles found in the labyrinth of the internal ear. They are enclosed in sacs, appearing as white specks; and are composed of carbonate of lime, with an organic basis, which is left after the action of dilute acetic acid.

OTONYS'SUS, Kol.—A genus of Sarcoptidæ (Anoplura). *O. sticholasius*, on the bat; other species. (Maddox, *M. Mic. Jn.* 1871, 144; Murray, *Ec. Ent.* 317.)

OTOS'TOMA, Carter.—A genus of Holotrichous Infusoria.

Char. Ovoid, mouth ear-shaped; anus terminal; nucleus long; contractile vesicles double. Its cysts have been discovered on *Nitella*, and give exit to monadiform beings approaching the parent shape.

O. Carteri, Bombay.

Bibl. Carter, *Ann. N. H.* 1866, xvii. 117; Kent, *Inf.* 500.

OVA of Animals.—The germs secreted by the ovaries. When extruded from the body, they are generally termed eggs (Eggs). See Ovum.

OVARY.—The organ in which the ova or germs of the future offspring are formed and temporarily contained.

The ovary consists of an outer fibrous capsule, and a parenchyma or stroma.

Fig. 538.

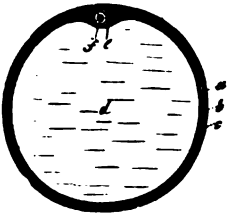
Transverse section of a human ovary at the fifth month of pregnancy. *a*, Graafian vesicle of the under, *b*, of the upper surface; *c*, peritoneum; *d*, the tunica albuginea; in the centre are two corpora lutea; *e*, stroma of the ovary.

The outer coat, or tunica albuginea, is firm, white, and intimately connected with the subjacent stroma: it consists of interlacing bundles of connective tissue with few elastic fibres.

A layer of columnar or germ-epithelium covers the capsule, therefore different from that of the peritoneum, with which it is continuous at the base of the organ. The germ-epithelium here and there lines tube-like inward prolongations (the ovarian tubes).

The stroma (fig. 538 *e*) is composed of nucleated connective tissue, and in it are imbedded the *Graafian vesicles* (fig. 538 *a*). They vary greatly in number and size; the largest are generally nearest the surface, and project more or less, so as to give it a nodular aspect. They are round closed sacs (fig. 539). Each possesses two coats; the

Fig. 539.



Graafian vesicle of the pig. *a*, outer, *b*, inner layer of the fibrous coat; *c*, membrana granulosa; *d*, liquid contained in the vesicle; *e*, proligerous disk; *f*, ovum with the zona pellucida, yolk, and germinal vesicle.

Magnified 10 diameters.

outer is a fibrous and vascular layer, connected with the stroma by somewhat lax areolar tissue, which consists of two layers: the outer composed of ordinary fibrous connective tissue; the inner consisting of young connective tissue, rich in cells, usually fusiform, stellate, or spheroidal, and resembling amœboid cells. Lining this is the epithelium of the follicle, which covers the whole of the inside of the tunica propria, and forms the *membrana granulosa* (fig. 539 *c*). Next the surface of the ovary this is thickened and projects inwards, forming the *proligerous disk*, *e*; the epithelium is stratified and columnar. The ovum is imbedded in this proligerous disk.

The cavity of the Graafian vesicle contains a liquid resembling the serum of the blood; and in it are found granules, nuclei, and cells, arising from the disintegration of the membrana granulosa.

When the vesicle bursts, the ovum es-

capes surrounded by the cells of the proligerous disk and the adjacent part of the epithelium; the inner surface then becomes wrinkled, and gives off fleshy processes which become yellowish, and form the corpora lutea.

In those animals in which the amount of stroma present is small in proportion to the size of the vesicles, the ovaries have a racemose appearance.

In many of the lower animals the ovaries are tubular, the ova lying closely packed within them.

BIBL. Kölliker, *Mik. An.* ii.; Siebold, *Vergl. An.*; Todd's *Cyclop. An.*; Waldeyer, *Stricker's Hist.*; Balfour, *Comp. Embryol.* 1880.

OVIPOSITOR. See INSECTS, p. 433.

OV'ULE or OV'ULUM.—The name applied to the rudiment of the seed of Flowering Plants, produced in the ovary or germen during the development of the flower, fertilized by the pollen-grains when complete; and afterwards converted into a SEED by the development of the EMBRYO and other secondary structures during the conversion of the ovary into the fruit. For the general conditions of the ovules in ovaries, reference must be made to botanical works. The ovules make their appearance upon the placenta as cellular papillæ rising up from its surface, and are at first simple; this first development, the main feature of the organ, is called the *nucleus* (figs. 540–542). In

Fig. 540.

Fig. 541.

Atropous ovules.

Fig. 540. Young ovule of Chelidonium. *n*, nucleus; *ch*, chalaza.

Fig. 541. Young ovule of mistletoe, consisting of a nucleus only.

rare cases this remains naked; but in most instances one or two coats are produced, arising as circular folds near the base, and gradually growing up over the nucleus (fig. 542), leaving only a small hole or passage at the apex, leading down to the point of the nucleus. When two coats are formed (fig. 543), the inner appears first; the outer originates later and grows up over the inner, and it is generally thicker and more developed. The inner is the *secundine* of Mirbel, the outer the *primine* (figs. 543, 544, 547, *S*, *P*). German writers reverse

Fig. 542.

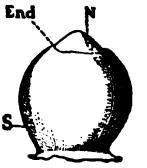
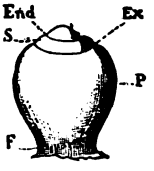


Fig. 543.



Atropous ovules.

Fig. 542. Young ovule of walnut, consisting of a nucleus *N*, with a single coat *S*; *End*, the endostome or micropyle.

Fig. 543. Young ovule of Polygonum. *F*, funiculus; *P*, primine (of Mirbel); *S*, secundine; *Ex*, exostome; *End*, endostome.

Magnified 40 diameters.

these names, resting on the true order of development. Some term them the *integumentum*, *internum* and *externum*. The inner is the *tegmen*, the outer the *testa* of Brown. The passage at the apex, leading to the nucleus, is called the *micropyle*; sometimes the orifice in the outer coat is distinguished from that in the inner coat, and they are termed respectively *exostome* and *endostome* (fig. 547). While the nucleus and coats are becoming perfected, one of the cells situated near the apex of the nucleus takes

Fig. 544.

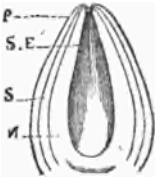
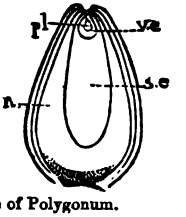


Fig. 545.



Sections of atropous ovule of Polygonum.

P, primine; *S*, secundine; *N*, nucleus; *SE*, embryo-sac: *V.e*, *Pl*, nascent embryo.

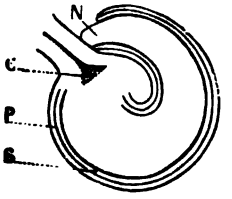
Magnified 20 diameters.

on a peculiar character, becoming more developed than the rest, and often causing the absorption of part, or sometimes the whole, of the tissue of the nucleus; it appears at length as a large sac occupying the centre of the ovule; this is the *embryo-sac* (fig. 544). The base of the ovule is pushed up from the surface of the placenta during its development so as to appear at length supported on a stalk of variable length; this is

termed the *funiculus* (figs. 543 *F*, 547 *f*); the point of attachment of this stalk to the body of the ovule (marked by a scar when the ripe seed separates) is called the *hilum*. That region of the interior where the lower parts of the coat are confluent with the base of the nucleus, is called the *chalaza* (fig. 546 *C*).

The form of ovules is much affected by excessive development of their constituent parts in special directions before the fertilization. If all parts grow equally, the complete ovule is erect on the placenta, with its hilum and also the chalaza turned towards the latter, and its micropyle at the opposite free end: such an ovule is technically termed *atropous* or *orthotropous* (figs. 541–545). Very frequently an excessive growth takes place at one side of the coats of the ovule, so that the chalaza is carried up and directed away from the placenta, the micropyle being at the same time turned down towards the latter; but as the growth is in the coats of the ovule, the hilum remains at the base, near where the micropyle arrives; such an ovule is termed *anatropous* (fig. 116, p. 157). The hilum is then connected with the chalaza by a ridge (a kind of adherent funiculus) called the *raphe*. In other cases the form becomes altered by the point of the ovule turning down, the entire structure becoming folded or bent upon itself, without disturbance of the relative positions of the hilum and chalaza, while the micropyle is brought down, as in the anatropous ovule, to the vicinity of the hilum. This form is termed *campylotropous* (fig. 546). Other conditions occur less frequently, among which is the *amphitropous* form (figs. 550 & 551).

Fig. 546.



Section of campylotropous ovule of the wallflower. *C*, chalaza; *N*, nucleus; *S*, inner coat; *P*, outer coat. Magnified 20 diameters.

During these developments the embryo-sac also undergoes various changes. Sometimes, as in the Orchidaceæ, it expands so as to obliterate all the tissue of the nucleus, and appears like a simple sac enclosed by

Fig. 547.

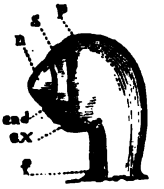


Fig. 548.

Fig. 549.

Magnified 40 diameters.

Fig. 550.

Fig. 551.

Magnified 20 diameters.
Amphitropous ovule of mallow in different stages.
Fig. 551. Section.

Up to this point the differences in ovules are such as may be termed secondary; but a primary distinction now comes into view, connected also with a difference in the external conditions, affording grounds for the division of the Flowering Plants into two great classes. In the Coniferæ and Cycadaceæ the ovules are developed upon open carpels, and consequently the micropyle may receive the pollen-grains immediately, when expelled from the anthers. Plants exhibiting this condition are termed GYMNOSPERMS, or naked-seeded. In the Dicotyledons and Monocotyledons the carpels are always closed up into cases or ovaries, surmounted by a *stigma*, sessile or elevated

upon a style, and the pollen, falling upon the stigma, produces there its pollen-tubes, which pass down through what is called the conducting tissue of the style and upper part of the ovary, on to the placentæ, whence they make their way to the micropyles of the ovules. Plants exhibiting these conditions are distinguished as ANGIOSPERMS or covered-seeded.

The next phenomena which characterize the development of the ovules of the Angiosperms may be briefly given as follows. The formation of the embryo-sac has already been described. Shortly before the opening of the flower, in most cases, this sac is more or less densely filled with granular protoplasm, in which a variable number of nuclei may be seen (Pl. 47. figs. 1–7). About the time when the pollen-grains are discharged from the anthers, a number of minute, free, globular protoplasmic bodies may be discovered in the embryo-sac, usually three (more rarely one) of these being crowded into the upper end of the embryo-sac and constituting what are called the *germinal bodies* or *masses* (Pl. 47. fig. 4). Others, which often occur in the embryo-sac, are generally collected near the bottom of it; they are apparently characteristic of particular families only; in some plants they are very large, as in the *Crocus*. About this time the embryo-sac often exhibits asymmetrical growth, forming pouches or processes, sometimes at the summit, sometimes at the base.

When the pollen-grains fall upon the stigma, they protrude their pollen-tubes (see POLLEN), which pass down through the conducting tissue, and enter the micropyles of the ovules. When they reach the apex of the embryo-sac, they either stop, often swelling a little, or they pass down a short way over its side (Pl. 47. fig. 5); very rarely two pollen-tubes are found engaged in the micropyle of the same ovule. It is not absolutely known whether the cavities of the pollen-tube and the embryo-sac become actually continuous by absorption of the walls at the point of attachment; it is generally believed not, but we feel some doubt on this point. The essential point of the process is the intermixture of the contents of the pollen-tube with the substance of the germinal body. In the higher Cryptogamia and in the Algæ, the impregnation is of a similar nature; but there the germ-masses are fertilized by the agency of spermatozoids, which make their way to them, either constituting or carrying the impregnating matter, which in the case of the pollen-tube is a liquid, containing fine granules, but exhibiting no trace of active spermatic bodies, except that refractive granules are sometimes seen in active motion in the end of the pollen-tube.

Soon after the pollen-tube has reached the point of the embryo-sac, one (rarely two, giving rise to POLYEMBRYONY) of the germinal bodies becomes invested by a cellulose membrane (*germ-cell*), and usually changes from a spherical to an oval form, a transverse septum soon dividing it into two. Most frequently the elongation continues, with a successive formation of septa, until the nascent embryo appears as a rounded or oval cellule suspended at the base of a simple confervoid filament (*suspensor*); in other cases the formation of the first transverse septum is followed by the expansion into two globular cellules connected by a narrow neck, the upper, almost devoid of contents, constituting the suspensor (*Potamogeton, Zannichellia*); in *Orchis*, the upper of the first two cells grows upwards and outwards, as a blind septate confervoid filament, through and beyond the micropyle of the ovule. In *Tropæolum* and *Zea* the suspensor becomes more complex, by formation of perpendicular septa. In all cases the end or *embryonal cell*, at the point of the suspensor, which always appears densely filled with protoplasm, ultimately enlarges, and by segmentation is converted into the *embryo* (Pl. 47. fig. 6).

During the early development of the embryo, the embryo-sac is often found more or less densely filled with free cells formed from its protoplasm (*endosperm*-cells). These are frequently absorbed, and disappear during the growth of the embryo, this ultimately filling the embryo-sac; while in other cases they persist and multiply, forming the ALBUMEN of the seed. In the Nymphæaceæ these cells remain, forming an inner Endosperm or Albumen, in addition to that formed from the body of the nucleus. In other cases (those of exalbuminous seeds) the embryo not only displaces these internal endosperm-cells, but in the course of its growth causes the absorption of the tissue of the nucleus, and ultimately constitutes the entire seed, enclosed only by the true integuments. The remaining characters are given under ALBUMEN and EMBRYO.

Tulasne is in doubt whether the germinal

vesicles exist before the pollen-tube enters the micropyle. We have certainly seen them before; but we believe they do not possess a cellular coat before impregnation. Observations on the ovule of *Santalum album* have led us to conclude that they receive the influence of the pollen while in the state of nucleated protoplasmic corpuscles, analogous to the unimpregnated spores of FUCUS; and this view has since been supported by the later observations of Schacht, although Hofmeister and Radlkofer maintain that the germinal bodies possess a cell-membrane before impregnation.

In the Gymnospermous Flowering Plants (Coniferæ, &c.) the ovule, consisting of a cellular *nucleus* and a single coat, is placed upon an open carpel, and its widely-open micropyle receives the pollen-grain. At the period of impregnation, the embryo-sac is a cavity deeply seated in the tissue of the nucleus; it is formed by the coalescence and expansion of several cells (in the Yew there are often at first three embryo-sacs). In the embryo-sac a number of free nuclei soon appear, and numerous free (endosperm-) cells are formed. In many of the Abietineæ this goes on until the spring following the impregnation. Ultimately the embryo-sac is found to have increased to more than twenty times its original size, with the endosperm-cells applied in layers over the inside of its walls, increasing in number until the cavity is filled up. Then a certain number of cells (from three to eight in different genera), situated near the micropyle end, but each in the layer next but one to the wall of the embryo-sac, become enlarged, and the cells intervening between these enlarged ones (secondary embryo-sacs) and the wall of the original embryo-sac become divided, by two perpendicular septa standing at right angles, into four cells. A central intercellular passage then appears at the contiguous angles of these four cells. These new bodies, which closely resemble the archegonia of the LYCOPODIACEÆ, were called *corpuscula* by Brown, who discovered them.

Free cells, or perhaps merely protoplasmic masses, are next formed in the secondary embryo-sacs of the corpuscula, several at the upper, one at the lower end. The pollen-tubes now advance, breaking down the tissue of the nucleus, until their points reach the *corpuscula*; and one then makes its way down the intercellular canal of each, to reach its secondary embryo-sac; the free cell at the base of this (*germinal vesicle*) then becomes divided into four collateral cells; these multiply again; and subsequently the cellular body (*proembryo*) so formed breaks through the base of the secondary embryo-sac, and grows down in the substance of the lower part of the nucleus, which is now in a state of semisolution. The proembryo then separates into four cords, corresponding to its four primary cells; and these filaments (suspensors) terminate in rounded cells, each of which is an *embryonal cell*; so that there are now four times as many rudimentary embryos as there are corpuscula. Out of all these, only one ultimately remains and becomes perfectly developed; the rest are absorbed during the ripening of the seed. In the latter, the perfect embryo is found lying in a mass of albumen formed of the nucleus; its *radicle*, developed at the point of junction of the suspensor, never becomes very clearly defined at its extremity, but remains organically continuous with the albumen.

Other points relating to the development of ovules will be found under POLYEMBRYONY, SEEDS, and CELL-formation.

The methods of investigating the development of ovules are simple in their nature, but rather difficult in practice. The ordinary plan is to place an ovule between the thumb and fore finger of the left hand, and with a very sharp lancet cut it into two unequal pieces, in the direction of the axis. The larger of the two being then laid on its flat side on the finger (by the aid of a mounted needle), another slice is made so as to leave a section preserving all the central part of the ovule. This adheres either to the finger or the lancet; and a drop of water should be placed on it to free it; then it may be transferred to a slide with a very fine camel's-hair pencil. Examined under a low power (a half-inch), it will probably be found to require further dissection, with exceedingly fine needles, under a simple lens; sometimes mere pressure is of service. For the minute details, the quarter and eighth object-glasses will require to be applied. We have found ovules which have been kept in spirit easier to dissect; when fresh, the cell-membranes are excessively delicate. It need scarcely be added that ovules require to be examined in all stages in order to understand their developmental characters; and the student must not be disheartened by the failure of a large proportion of his sections to afford satisfactory observations.

Bibl. Brown, *App. to King's Voyage*, 1826; *Linn. Tr.* 1833; Mirbel and Spach, *Ann. Sc. Nat.* 2 sér. xx. 257; Mohl, *Bot. Zeit.* 1847, 1855; Müller, *ibid.* 1847; Schleiden, *Nova Acta*, xix. 29; *Grundz. Bot.*; Hofmeister, *Entsteh. d. Embryo*, 1849; *Unters. höher. Crypt.* 1851; *Abh. K. sächs. Ges.* vi.; Hanstein, *Flora*, 1857; Tulasne, *Ann. Sc. Nat.* 3. xii. 21, 4. iv. 65; Schacht, *Beitr. z. An. u. Phys.* 1854; *Jahrb. wiss. Bot.* i. 1857; *Bot. Zeit.* 1858; Crüger, *Bot. Zeit.* 1851, 1856; Radlkofer, *Entsteh. des Embryo*, 1856; Henfrey, *Linn. Tr.* xxi. 7, xxii. 69; *Tr. Brit. Assoc.* 1856; Bentley, *Man. Bot.*; Henfrey-Masters, *Bot.*; Chatin, *Ann. Sc. N.* xix. 1874, 1; Sachs, *Bot.* 558; Strassburger, *Zellenbildung*, 1880.

OVULITES, Lamarck (*Oveolites*).—A large elegant one-celled Foraminifer, regarded by some as a calcareous Alga; either ovoid, sausage-shaped, or like a drumstick; shell porous, with large terminal apertures; length 1-25″ and more.

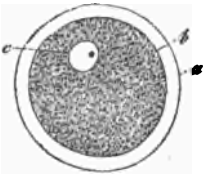
Fossil; abundant in the Eocene of Grignon, Hauteville, &c., France; rare in the Miocene of San Domingo.

Bibl. Parker & Jones, *Ann. N. H.* 3. v. 292, and 1877, xx. 77.

OVUM OF ANIMALS.—Several points in regard to the structure of the ovum, and the nature of the changes which it undergoes at different periods of its development, are in doubt and obscurity.

The first perceptible trace of the ovum existing within the ovary is formed by a very minute granule or globule, not surrounded by a cell-wall. This gradually enlarges; and when it has attained a certain size, being still very minute, a smaller spherical globule forms in its interior. The minute internal globule is the *germinal spot*; and the external globule is the *germinal vesicle*. It appears, however, that in some cases the germinal spot is formed first, and the germinal vesicle subsequently. When these have still further grown, a cell-wall separated by a slight interspace forms around the germinal vesicle; and this interspace contains a transparent liquid. Minute granules then arise in the liquid, which becomes inspissated; and subsequently a number of globules of sarcode — *yolk-globules*—become perceptible in it; this mass forms the *yolk*; and the surrounding membrane is the *vitelline membrane*. As the ovum attains further development, albuminous layers are deposited upon and fused with the vitelline membrane, forming the *zona pellucida* or chorion (fig. 552 *a*),

Fig. 552.



Human ovum from a Graafian vesicle of moderate size. *a*, zona pellucida; *b*, vitelline membrane and outer boundary of the yolk; *c*, germinal vesicle with the germinal spot.

Magnified 250 diameters.

which appears as a white ring. The yolk-globules are sometimes transparent, or slightly granular; at others they contain one or several vacuoles, and are frequently aggregated into little groups. The yolk, as it approaches maturity, frequently becomes coloured. It is usually whitish or pale yellow in the Mammalia, Reptiles, and Fishes, bright yellow or reddish in many Birds, and often green, blue, violet, or red in the Invertebrata. In the yolk of the ova of reptiles and fishes, crystalline plates are met with, consisting of an albuminous substance, allied to Hæmatoidine.

Viewing the ovum as a simple cell, the germinal spot represents the nucleolus, the germinal vesicle the nucleus, the vitelline membrane or zona pellucida the cell-wall, and the yolk the cell-contents.

Some authors consider that the vitelline membrane is formed after the chorion.

The ovum of man and the mammalia differs from that of the lower animals in its remarkably small size, which depends upon the extremely small quantity of yolk entering into its composition. The mature ovum of man and mammalia averages about 1-200 to 1-150″ in diameter, being rarely 1-100″. Another peculiarity consists in their ova, instead of being in immediate contact by means of their chorion or outer envelope with the stroma of the ovary, or loose within the cavity of the latter, as in other animals, being enclosed in distinct larger cells—the Graafian vesicles.

On the escape of the ovum from the ovary, the phenomena which ensue vary according to whether the ovum has been impregnated or not. In both cases the germinal vesicle and spot disappear; an interspace, filled with albuminous liquid, occurs between the yolk and the zona pellucida; the ovum

becomes covered with cilia, and undergoes a regular motion of rotation; and certain movements and changes in form of the yolk-substance, which forms Amœba-like processes, have been noticed. In the unimpregnated ovum, decay and decomposition subsequently take place.

The essential part of the process of impregnation consists in the penetration of the yolk by the spermatozoa, and their subsequent solution in it. This takes place either through the micropyles or the radiate canals, or directly into the naked yolk.

In the impregnated ovum, the germinal vesicle soon disappears, the chorion becomes thinner, the ovum grows, and the yolk begins to undergo segmentation; but just before this process commences, one or two globules separate from the substance of the yolk, being apparently pressed out of it, and occupy the interspace between the yolk and the chorion; these globules subsequently dissolve in the liquid.

In the process of segmentation, at first a notch or slight indentation appears on some part of the surface of the yolk; this becomes deeper and deeper, so as to encircle the yolk with an annular depression. Soon after the commencement of this, a clear spot appears in the centre of each circumscribed portion of the yolk. The depression becoming deeper, the yolk is divided into two distinct portions. The process is continued in the case of each of these in exactly the same manner, and in that of the segments arising from their subdivision also, each simultaneously acquiring a clear spot, until the yolk appears entirely composed of innumerable small bodies having the appearance of nucleated cells. Finally these become very minute, and the yolk acquires much the appearance it had before impregnation. Cells then form in the yolk, as in an ordinary blastema, from without inwards, and from the spot originally occupied by the germinal vesicle as a centre; and from these the tissues of the embryo are formed.

According to this description, the segmentation is not a process of cell-division or endogenous cell-formation, and the nuclear spots would correspond to portions of the yolk substance from which the granules and globules of sarcode were absent. Compare p. 140.

In unimpregnated ova, segmentation takes place to a certain extent, but irregularly and incompletely.

In the impregnated ova of some animals, as in certain of the Batrachia, most fishes and Cephalopods, the segmentation is only partial, a portion of the yolk remaining as at first.

In some of the Mammalia, the zona pellucida is traversed by very fine radiating lines (canals), which are best seen in ova immersed in water.

In the lower Vertebrate animals, the ova are often covered by new layers, secreted by the ovaries, as in the Batrachia (frog, &c.), where a thick gelatinous coat is present. In the osseous Fishes, the vitelline membrane is frequently elegantly sculptured, and finely and closely punctate from the existence of minute canals traversing its substance. A second coat is also present, and sometimes a third or albuminous layer. In many of the Cyprinoidea, this layer is represented by small radiate cylinders. In several Fishes, as is so general amongst the Invertebrata, especially Insects (Eggs), the vitelline membrane or chorion exhibits a facetted or sculptured appearance, derived from the impression of the epithelium lining the ovarian passages.

In addition to the fine canals traversing the membranes of the ovum, one or more large canals or apertures are frequently met with resembling the micropyles of vegetable ovules, and receiving the same names; these are most distinct in the ova of fishes and insects.

The study of ova and their changes is very difficult. The most favourable objects for the purpose exist perhaps in those of the aquatic Mollusca; the ova of insects, as the large species of *Musca*, of species of *Pulex*, &c. are also easily accessible. Some important results have been obtained with the ova of the frog (frog's spawn).

Bibl. Kölliker, *Mik. An.* ii.; Thomson, *Cycl. An.* art. *Ovum*; Newport, *Phil. Tr.* 1851 and 1853; Siebold, *Vergl. An.*; Meissner, *Sieb. & Köllik. Zeitsch.* vii. 208, 272; Leuckart, *Müll. Archiv*, 1855; Claparède, *Bibl. Univ. Genève*, 1855; *Ann. N. H.* 1856, xvii.; Bischoff, *Sieb. & Köll. Zeit.* vi. 377; Radlkofer, *Befruchtungs.* 1857; Beneden & Bessels, *M. M. J.* 1869, 41; Kupffer, *M. Mic. Jn.* 1869, 47; Kowalevski, *Mém. St. Pétersb.* xvi. 1871; Klein, *M. M. J.* vii. 1872, 193; Beale, *Tr. Mic. Soc.* 1867; *How &c.* 307; Beneden, *l'Œuf*, 1870; Dallinger & Drysdale, *M. M. Jn.* xviii. 86; Schäfer, *Pr. Roy. Soc.* no. 168; Kölliker, *Entwickel.*; Balfour, *Comp. Embryol.*; M. Baker, *Phys.*

1880; His, *Menschl. Embryo*, 1880; Reichert, *Menschl. Frucht.* 1873; Girdwoyn, *Mal. d. Œufs* (fish), 1880.

OVUM OF PLANTS. See OVULE.

OXALATES. See the bases.

OXYR'RHIS, Duj.—A genus of Flagellate Infusoria, belonging to the family Thecamonadina.

Char. Body ovoid-oblong, rugose, obliquely notched in front and prolonged into a point; several flagelliform filaments (two, Kent) arising laterally from the bottom of the notch.

O. marina (Pl. 31. fig. 54). Body colourless, subcylindrical, rounded behind; marine; length 1-500″.

BIBL. Dujard. *Inf.* 347; Pritchard, *Inf.* 513.

OXYT'RICHA, Bory, Ehr.—A genus of Hypotrichous Infusoria, of the family Oxytrichina.

Char. Closely resembling *Stylonychia*; but the front of the body not produced.

O. pellionella, E. (Pl. 31. fig. 52). Body whitish, smooth, slightly depressed, equally rounded at the ends, often somewhat broader in the middle; head not distinct; mouth ciliated; tail with bristles. Freshwater; length 1-720 to 1-280″.

O. gibba E. (Pl. 31. fig. 53). Body white, lanceolate, obtuse at each end, ventricose in the middle; ventral surface flat, with a double row of setæ; mouth large, rounded. Freshwater; length 1-240″. Other species.

According to Haime, *Oxytricha* is the larva of *Aspidisca*.

BIBL. Ehr. *Inf.* 363; Duj. *Inf.* 416; Haime, *Ann. Sc. Nat.* 3. xix. 109; Clap. et Lachm. *Etudes*, 139; Kent, *Inf.* 786.

OXYTRICHI'NA.—A family of Hypotrichous Infusoria.

Char. Carapace absent; body depressed, with vibratile cilia, setæ, or cirri, and non-vibratile styles or hooks. Movement crawling. Alimentary orifices two, neither terminal.

Genera:—

OXYTRICHINA.
- Marginal cirri
  - Foot-cirri in regular rows, longitudinal or oblique...
    - The anterior part of the body not prolonged as a neck, furnished with cirri — *Oxytricha.*
    - The anterior part of the body neck-like, and covered with cirri — *Stichochæta.*
  - Foot-cirri not arranged in rows — *Stylonychia.*
- No marginal cirri
  - With frontal cirri
    - Foot-hooks exist
      - No dorsal bristles — *Euplotes.*
      - Dorsal bristles — *Schizopus.*
    - No foot-hooks — *Campylopus.*
  - Without frontal cirri — *Aspidisca.*

BIBL. Ehr. *Inf.* 362; Pritch. *Inf.* 639; Clap. et Lachm. *Etudes*, 168.

OXYUR'IS, Rud. See ASCARIS.

OY'STER (*Ostrea*).—A genus of Lamellibranchiate Mollusca.

The gills of *O. edulis*, the common oyster, show the ciliary movement; but it is not so easily seen in this as in the marine mussel.

The shells of the fry or 'embryo oysters' exhibit the black cross and an imperfect set of coloured rings with polarized light.

P.

PACHNOC'YBE, Berk.—A genus of Isariacei (Hyphomycetous Fungi), somewhat confused by authors with *Doratomyces*, Corda, and *Periconia*, Nees. These plants have an erect filiform stem, composed of conjoined filaments, capitulate above, the head being pruinose (not flocculent), with crowded simple spores. The pedicels are mostly brownish or blackish, the spores light-coloured; the entire plants from 1-24 to 1-6″ high. Several species occur on rotten wood, stems, &c.

BIBL. Berk. *Hook. Br. Fl.* ii. pt. 2. 333; *Ann. N. H.* 2. v. 465; Fries, *Sum. Veg.* 467.

PACHYG'NATHUS, Dugès.—A genus of Trombidina (Acarina).

Char. Palpi conical, last joint scarcely forming a claw; mandibles stout, chelate; body entire, narrowed in front; coxæ distant; legs gressorial, sixth joint very long, seventh very short; anterior legs longest and stoutest.

P. velutinus (Pl. 6. fig. 34), the only species. Found in autumn, under damp stones. Hairs covering the body short, flat, and curved, giving it a velvety aspect. Body inflated, narrowed in front, the narrowed portion with two projecting brownish eyes. Insertions of the legs in two groups, not far distant, or from the median line; second pair of legs shortest; in all the sixth joint very long, the seventh very short and narrow (*b*), as in *Tetranychus*, *Megamerus*, and *Raphignathus*; claws two, large; rostrum projecting; palpi (*a*) short, about twice the length of the labium; mandibles very large and stout at the base. Movement slow.

BIBL. Dugès, *Ann. Sc. Nat.* 2. ii. 54; Gervais, *Walck. Aptèr.* iii. 171.

PACHY'MA, Fr.—A supposed genus of Sclerotiacei, but probably a condition of certain roots, the substance being converted into pectic acid. It is well known in the United States under the name of Tuchahoo.

Bibl. Fr. *Syst. Myc.* ii. 242; Berk. *Int. Crypt. Bot.* 254.

PACHYMATIS'MA, Bowk.—A genus of marine Sponges.

Distinguished by the fleshy, crust-like, not cellular nor elastic mass, covered by a thick skin, and perforated by scattered orifices; the interior beset with siliceous acicular and stellate spicula. *P. Johnstonia.* (Bowerbank, *Brit. Spong., Ray Soc.*)

PACHYPHLŒ'US, Tul.—A genus of Tuberacei (Ascomycetous Fungi), with a common warty integument opening by a terminal aperture with a distinct base, clavate asci, and spherical sporidia. Three species occur in Great Britain.

Bibl. Tul. *Fung. Hyp.* 130; Berk. and Br. *Ann. N. H.* xiii. 359, xviii. 79; Berk. *Outl.* 377; Cooke, *Handb.* 743.

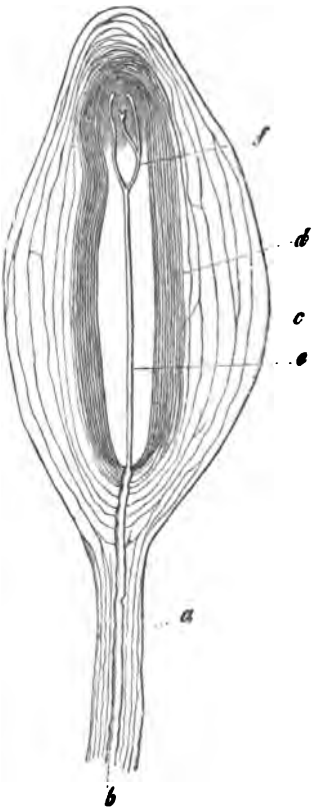
PACHYT'ROCHA, Kent.—A genus of Peritrichous Infusoria. Like *Cothurnia*, but with a fleshy pad closing the carapace. *P. cothurnoides*; pond-water. (Kent, *Inf.* 729.)

PACINIAN CORPUSCLES. — These curious organs form terminations or appendages of the spinal nerves in the skin and subcutaneous tissue of the palm of the hand, the sole of the foot, the fingers and toes, in the sympathetic semilunar ganglia, the mesentery, &c.

They are elliptical or pear-shaped, whitish, and about 1-25 to 1-6″ in diameter. Each consists of from twenty to sixty concentric layers of connective tissue (fig. 553), separated by interspaces, those between the outer layers being considerable, those between the inner being small; each is lined with epithelium. They surround a cavity filled with soft, abundantly nucleated and very easily alterable material, which undergoes coagulation after death, and into the interior of which the nerve-fibres penetrate. They are filled with a clear serous liquid; each is also furnished with a stalk, containing a slender nerve-fibre, which passes into the central space, in which it terminates, frequently in two or three branches, each with a granular tubercle.

The Pacinian corpuscles are met with also on the nerves of many Mammalia, and are very numerous in the skin, the beak, and the tongue of birds. They are readily examined in the mesentery of the cat.

Fig. 553.



A human Pacinian corpuscle. *a*, stalk; *b*, nerve-fibre within it; *c*, outer, *d*, inner layers of the sheath; *e*, pale nerve-fibre in the central cavity; *f*, its termination. Magnified 350 diameters.

Bibl. Kölliker, *Mik. An.* ii.; Schultze, *Stricker's Hist.*

PADI'NA, Adanson.—A genus of Dictyotaceæ (Fucoid Algæ), containing one species, *P. Pavonia* (fig. 554), found rarely in summer and autumn on the south coast of England. The fan-shaped or reniform fronds grow in tufts, and are 2 to 5″ high, sometimes entire, sometimes cleft (fig. 554). They are marked with concentric zones. The substance is parenchymatous — the number of layers of cells diminishing, with the thickness and solidity, from the base to the edges. The back of the frond is covered

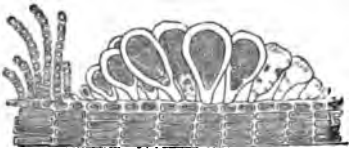
by a layer of cells much smaller than the rest, forming a kind of epidermis, which ultimately acquires a thickish cuticular

Fig. 554.

Padina Pavonia.
Frond, one third natural size.

layer. The growing edge of the frond is rolled backwards (circinate) and fringed. The fructification occurs in linear concentric sori, on the coloured zones of the frond. The pear-shaped *spore-sacs* (fig. 555) originate from cells of the epidermal layer, which

Fig. 555.



Vertical section of a frond at a concentric zone, made in a radial direction, cutting through the sorus of spore-sacs and a line of hairs. The indusial layer of cuticle has been removed.
Magnified 50 diameters.

take on special development, and in the course of their growth push up and finally burst through the loosened cuticular layer which originally clothed them, so that the latter forms a kind of indusium like that of the Ferns. The spore-sacs produce each four spores, which separate after their escape from the sac. The zones of the sori alternate with zones composed of tufts of jointed hairs placed in corresponding lines (fig. 555). Thuret states that he has never found *antheridia* hitherto, and he believes that Agardh mistook the hairs or paranemata for them.

Bibl. Harvey, *Mar. Alg.* 37, pl. 6 C; *Phyc. Br.* pl. 91; Grev. *Alg. Br.* pl. 10; Agardh, *Sp. Alg.* i. 112; Nägeli, *Algensyst.* 180, pl. 5; Thuret, *Ann. Sc. Nat.* 4 sér. iii. 12; Kütz. *Phyc. gen.* pl. 22; Al. Braun, *Rejuvenescence, Ray Soc.*, 1853, 79.

Palmel'la, Lyngbye (Red snow and gory dew).—A genus of Palmellaceæ (Confervoid Algæ), of which the best known example is the common *P. cruenta* (Pl. 7. fig. 3 *a*). This plant, very common on damp walls in shaded places, appears at first in the form of rosy gelatinous patches; these spread and become confluent until the mass extends sometimes over a great extent of surface, as a tough, gelatinous, irregular mass, of the colour and general appearance of blood; when dried up in this state, it forms a horny, somewhat crumbling stratum; if placed in water, portions float to the top in pellucid rosy masses of jelly.

When placed under the microscope, the frond appears to be composed of a colourless homogeneous jelly, in which are imbedded globular cells, single or in pairs (from division), of a beautiful rose-colour (fig. 3, *a*, *b*); by the application of reagents, these may be shown to possess a proper membranous coat (*c*). The contents of the cells appear uniformly granular (*b*, *c*); and it would appear that, besides increasing by division, the cells also burst and discharge their contents, since patches of minute granules occur imbedded in the jelly (lower figs. of *b*), probably destined to grow up into the ordinary cells. No zoospores, nor the remarkable phenomena generally that occur in *Protococcus*, have yet been observed in this, which appears to be a very distinct genus. The jelly of full-grown fronds (which appears to be derived from the gelatinous softening of the coats of the parent cells of the successive generations of cells) is often overgrown and discoloured by minute filamentous structures, which at first sight seem to belong to it; but on the application of a high power are found to consist of a very minute Nostochaceous plant, apparently the *Anabaina subtilissima* of Kützing, or *Vibrio bacillus*, Ehr. (Pl. 7. fig. 21), which we find to occur commonly among the Palmellaceous Algæ.

From the examination of specimens of the true "red snow," brought home by Captain Parry, we incline to regard this as a *Palmella*, distinct generically from the *Protococcus* or *Hæmatococcus pluvialis* of German writers, with which it is commonly associated. Our specimens consist of a tough, colourless, gelatinous substance, containing globular cells differing only in size (Pl. 7. fig. 3 *d*) from those of *Palmella cruenta*; and in the jelly occur also abundance

of the minute granules or cells, which are the discharged contents of the larger cells. The red cells of the red-snow plant turn green when exposed to light, if kept moist. An exactly similar plant has been given us by Mr. Oliver, from Crag Lough, Northumberland, in a fresh condition; and we have never been able to detect any moving forms in it. Further particulars are given under RED SNOW and WATER. Several other species of *Palmella* are described; but most of them are too imperfectly known to allow of definite characters being given; *P. rosea* is perhaps a good species. The forms with a definite frond formerly placed here (*P. protuberans, botryoides*, &c.) will be found under COCCOCHLORIS.

BIBL. *Eng. Bot.* pl. 1800; Greville, *Alg.* pl. 205; Meneghini, *Tr. Turin Ac.* 2. v. pl. 6; Hassall, *Alg.* pl. 80; Nägeli, *Alg.* 66, pl. 4 D; Kütz. *Sp. Alg.* 211; Rabenht. *Alg.* iii. 32. See also RED SNOW, and PROTOCOCCUS.

PALMELLA'CEÆ.—A family of Confervoid Algæ, consisting of gelatinous or pulverulent masses, growing on damp surfaces, in fresh water or in the sea; composed of globular or elliptical cells, either more or less adherent together into a definite or indefinite pseudo-membrane or frond, or loosely aggregated within a definitely or indefinitely formed gelatinous matrix, or loosely coherent in the form of a pulverulent crust. Some authors have imagined that the cells of *Coccochloris* or *Palmella* are attached to filaments included in the gelatinous frond: this seems an error (see PALMELLA). Yellowish or bluish-green, or red, often varying from green to red, and *vice versâ*, during the course of development. Increased by cell-division into two or four, and by ciliated zoospores. Many exhibit three forms:—1. active; 2. quietly vegetating by subdivision; 3. resting form, with a tough membrane. We include here, for the sake of convenience, not only the true Palmellaceæ, where there is a frond composed of a number of cells held together by mucus, but also all those Unicellular Algæ which, from their mode of increase, are found living socially or in masses which appear like Palmelloid plants.

Synopsis of Genera.

* *Cells immersed in a colourless gelatinous frond.* † *Frond amorphous.*

Palmella. Frond a slimy stratum, crowded with rather large globular green and red cells, multiplying by division (Pl. 7. fig. 3).

Microhaloa. Frond mucoid, floating in water, densely crowded with minute cells, multiplying by division, green or red.

†† *Frond definite.*

Glœocapsa. Cells enclosed in wide gelatinous coats, enclosed in similar wide gelatinous parent coats for several generations (Pl. 7. figs. 4 & 13).

Botrydina. Frond globose, the periphery composed of cells cohering into a kind of cellular epidermis; inner cells free (Pl. 7. fig. 9).

Coccochloris. Frond gelatinous, globose, containing numerous distinct cells, all free (Pl. 7. fig. 6).

Clathrocystis. Frond gelatinous, at first globose, then hollow and broken into a coarse net, crowded with minute cells (Pl. 5. fig. 9).

Merismopædia. Frond very minute, flat, square, containing cells in families of four, sixteen, and sixty-four (Pl. 7. fig. 12).

Urococcus. Frond composed of striated gelatinous tubes, formed of the parent cell-membranes in a single row, with solitary or binary cells in the ends (Pl. 7. fig. 7).

Hormospora. Frond a wide, gelatinous, simple or branched sheath, containing a single row of cells in twos or fours (fig. 336, p. 395).

Tetraspora. Frond gelatinous, foliaceous; cells in fours, becoming free as zoospores (Pl. 7. fig. 10).

Hydrurus. Frond toughly gelatinous, filiform, containing imbedded longitudinal rows of cells (Pl. 7. fig. 8).

Palmodictyon. Frond gelatinous, filiform, branched; branches anastomosing into a net, consisting of large vesicular cells, with coloured contents which escape as zoospores.

** *Cells single, either solitary or united in small numbers into families* (Unicellular Algæ).

Schizochlamys. Cells free, globular, green, aggregated in a jelly, each dividing into 2 or 4 portions, set free by the parent cell breaking into 2 or 4 segments.

Chlorosphæra. A large free globose cell, with green contents, ultimately dividing into two cells, each forming a new cell like the parent, set free by lateral rupture (Pl. 5. fig. 4).

Characium. A minute attached, pyriform, fusiform, or rounded, shortly stipitate sac

containing green protoplasm, which by repeated binary division forms a swarm of active 2-ciliated zoospores escaping by a lateral or terminal slit (Pl. 5. fig. 2).

Apiocystis. A simple attached sac with a stout membrane, with green contents, consisting at first of groups of four still gonidia, which subdivide repeatedly, and as the parent sac grows become converted into innumerable active zoospores, which move in the parent sac and then break out in a swarm (Pl. 5. fig. 5).

Codiolum. An attached small, long clavate sac, forming a stipes below, filled with granular green contents, with starch-corpuscles, finally converted at once into numerous globose gonidia, escaping by rupture of the sac (Pl. 5. fig. 6).

Hydrocytium. An attached minute shortly stalked oblong sac, with green contents, and a parietal starch-corpsule. Contents finally divided into numerous 2-ciliated zoospores, breaking out in a swarm (Pl. 5. fig. 1).

Ophiocytium. Single or rarely in families; composed of a minute cylindrical curved sac, with a short stipes, free or attached; green contents scattered, finally forming 8 gonidia in a row, set free by the circumscissile rupture of the end of the sac (Pl. 5. fig. 11).

Sciadium. At first a stalked tubular sac, with 8 gonidia, which grow from the orifice in an umbel, finally emitting 2-ciliated zoospores (Pl. 5. fig. 3).

Chytridium. A minute parasitic globular or urceolate rooted sac; cell-contents colourless, finally converted into 2-ciliated zoospores (Pl. 5. fig. 7).

Pythium. Parasitic; a colourless globular sac, living in the interior of diseased Confervoids, often in groups, the neck perforating the nurse-plant, emitting active gonidia (Pl. 5. fig. 8).

Bibl. Braun, *Rejuven., Ray Soc.* 1851; *Alg. Unicell.* 1855; *Chytridium*, 1856; Nägeli, *Einzell. Algen*, 1849; Kütz. *Spec. Alg.* and *Tab. Phycol.* i.; Cohn, *Nova Acta*, xxiv.; Rabenh. *Alg.* iii.; Cooke, *Freshwater Algæ*, 1882.

PALMELLI'NA, Radlk.—A doubtful genus, allied to *Palmella*, or probably Fungi. Thallus flocculent; cells very minute, some smaller and globular, others larger, elliptical or elongate. In the mud of wells and fountains; and beneath the epidermis of the scalp!

Bibl. Rabenh. *Alg.* iii. 35.

PALME'RIA, Grev.—A genus of Diatomaceæ from Hong Kong.

Bibl. Grev. *Ann. N. H.* 1865, xvi. 1.

PALMICELLA'RIA, Alder.—A genus of Escharidæ (Cheilostomatous Polyzoa). Orifice of the capsules with a palmate or mucronate process, with an avicularium on its inner aspect. Four species; marine, deep water. (Hincks, *Br. Zooph.* 378.)

PALMITIC ACID is a constituent of most neutral animal and vegetable fats; it exists in combination with glycerine, forming palmitine. When crystalline it forms pearly scales.

PALMODAC'TYLON, Näg.—A supposed genus of Unicellular Algæ, germinating spores of a Moss?

P. varium consists of a group of radiating single cells, or short multicellular filaments; ends rounded; numerous green masses in each cell. The cell-wall bursting in definite directions, sets free active gonidia. In freshwater pools.

Bibl. Nägeli, *Einzell. Alg.* pl. 2. fig. B; Rabenh. *Alg.* iii. 43.

PALMODIC'TYON, Ktz.—A genus of Palmellaceæ (Confervoid Algæ). Frond forming a delicate gelatinous network, composed of single or double rows of large vesicular cells, 1-600 to 1-960″ in diameter; containing a pair of elliptical green cellules, 1-3000″ in diameter, which ultimately escape as active zoospores. This genus appears identical with *Trypothallus*, Hook. and Harvey, and is nearly related to Hydrurus and Tetraspora.

P. rufescens, Ktz., doubtfully referred here, is larger; it occurs near Aberdeen.

Bibl. Kütz. *Sp. Alg.* 234; *Tab. Phyc.* Bd. i. pl. 31; Rabenh. *Alg.* iii. 37.

PALMOGLŒA, Ktz. See Coccochloris.

Bibl. Archer, *Qu. Mic. Jn.* 1864, 124; Rabenh. *Alg.* iii. 116.

PALMOPHYL'LUM, Ktz.—A genus of Palmellaceæ (Confervoid Algæ). 1 species, found in the Adriatic.

Bibl. Rabenht. *Flor. Eur. Alg.* iii. 49.

PALUDEL'LA, Ehr.—A genus of Meesiaceæ, having only one representative, which occurs in Britain, *P. squarrosa* = *Bryum squarrosum*, L.

PALUDICEL'LA, Gervais.—A genus of Polyzoa.

Char. Polyzoary fixed, filamentous, diffusely and irregularly branched, coriaceous, consisting of a single row of club-shaped cells arranged end to end; apertures unilateral, tubular, placed near the broad end of

each cell; tentacular disk circular, with a single row of free tentacles.

P. articulata. The only species; olive-green; polypes ascidian. Freshwater; diameter of filaments about 1-30 to 1-20″.

Bibl. Johnston, *Br. Zooph.* 405; Allman, *Ann. N. H.* xiii. 331, and *Pr. Irish Ac.* 1843.

PAM'PHAGUS, Bailey.—A genus of Rhizopoda allied to *Lieberkuehnia*. *P. mutabilis* is amœbiform, covered with a delicate elastic integument. Bailey, *Amer. Jn. Sci.* xv.; Pritchard, *Inf.* 551; Claparède et Lachmann, *Etudes*, 465; Archer, *Qu. M. J.* 1871, 101.

PANDORI'NA, Bory (Pl. 5. fig. 10).—A genus of Volvocineæ (Confervoid Algæ), which we believe to be synonymous with *Eudorina*. It exhibits a great variety of forms, some of which have been described under the name of *P. Morum*, others of *Eud. elegans*. The most characteristic conditions are represented in Pl. 5. fig. 10. *Pandorina* stands midway between *Volvox* and *Stephanosphæra*,—consisting of an ellipsoidal translucent gelatinous sac, containing imbedded just within its surface, several zone-like rows of green pear-shaped gonidia, whose two cilia penetrate the gelatinous envelope, and, hanging out free, move the entire organism by their vibration. Two distinct forms occur—one with sixteen, the other with thirty-two gonidia. Where sixteen occur, there are four zones of four gonidia, while where thirty-two exist they stand in four zones of eight, with four at each end (Pl. 5. fig. 10 *a* and *b*). The gonidia have a red spot and a vacuole, like those of *Gonium* and *Volvox*. These two forms occur together; and evidently the difference arises simply from an additional binary subdivision of the gonidia in the earlier stages of development from the spore. They are often so numerous as to tinge the water of fresh pools green, like *Volvox* and *Protococcus*. They occur of various sizes, from 1-80″ downwards.

These forms are multiplied vegetatively by the conversion of each gonidium into a family like the parent, each group acquiring its special envelope and becoming free by the solution of the parent-envelope. Two corresponding forms also occur with the above, with the sixteen or thirty-two gonidia closely crowded together, instead of standing at wide intervals in the large colourless envelope.

The resting-spores are formed out of all or part of the gonidia of a family, after conjugation (fig. 139*, p. 205). The impregnated gonidia soon acquire a stout special coat, and their originally green contents turn red; they become free by the solution of the parent-envelope. In germination they turn green again, and by repeated division of their protoplasm, form the new families of sixteen or thirty-two, constituting the perfect plant.

Fertilization of the gonidia has also been described as being produced by the action of spermatozoids—minute, fusiform, ciliated corpuscles, produced in large numbers by the subdivision of certain of the gonidia. This seems doubtful.

Bibl. Ehr. *Inf.* 53; Duj. *Inf.* 317; Henfrey, *Mic. Tr.* 2. iv. 49; Fresenius, *Mus. Senckenb.* ii. 187; Cohn, *Nova Acta*, xxvi. 1; De Bary, *Bot. Zeit.* xvi., *Supp.* ii. 73; Currey, *Q. Mic. Jn.* vi. 213; Carter, *Ann. N. H.* 3 ser. ii. 237; Rabenhorst, *Alg.* iii. 99; Pringsheim, *Monatsb. Berl. Ak.* 1869; Sachs, *Bot.* 258.

PANNA'RIA, Del.—A genus of Placodei (Lichenaceous Lichens). Several species. (Leighton, *Lich. Fl.* 150.)

PANOPH'RYS, Duj. = Frontonia pt.

P. chrysalis (Pl. 31. fig. 55). Marine.

Bibl. Duj. *Inf.* 491; Claparède & Lachm. *Etudes*, 260.

PANTOTRICHUM, Ehr.—A genus of Infusoria.

P. lagenula, E. (Pl. 31. fig. 58). Body ovate, equally rounded at each end, yellowish; tegument produced in front in the form of a neck or truncate rostrum; length 1-1080 to 1-580″.

Bibl. Ehrenberg, *Inf.* 247; Dujard. *Inf.* 388; Clap. et Lachm. *Inf.* 315.

PAPER.—A few general observations only can be made under this head. Ordinary paper, as is well known, was generally manufactured from rags of linen or cotton fabrics, so that it consisted of a kind of felt of the fibres of cotton or flax; but in consequence of the immense demand for paper, other substances, such as straw, jute, esparto, the pulped woody fibres of the poplar and pine, are now largely used. The manipulation to which the material is subjected, together with the effect of frequent washing in the case of rags, affects the characters of the fibres to some extent; and the cellulose is in some cases already brought into that state in which iodine colours it blue. The addition of sulphuric acid and iodine colours the fibres of most papers blue; and care

must be taken on this account to avoid errors from the accidental presence of them when blotting-paper is used to absorb these reagents when applied to objects on a slide. The determination of the nature of the filaments of which a paper is composed, by the aid of the microscope, requires a thorough knowledge of the characters of vegetable fibres. The structure of the various fibres is noticed under the individual heads. Latterly the use of the fibres of the purple bog melic-grass, *Molinea cærulea*, has been introduced.

Rice-paper, as it is termed, is a totally different material, consisting of thin layers, cut by a peculiar operation, of the pith of *Aralia papyrifera*, a Chinese Araliaceous tree: this consists of parenchymatous cellular tissue.

Papyrus, consisting of pressed superposed laminæ of the pith of the *Papyrus* plant, *Papyrus antiquorum*, a kind of Sedge, exhibits the lax parenchymatous structure characteristic of similar tissues, as in the Rushes, &c.

PAPER, METEORIC, and AEROPHYTES.—The structure of these substances is the same as that of the so-called natural flannel (FLANNEL). They were formerly regarded as of meteoric origin. They have been observed in some instances to fall from the air, having been wafted perhaps many miles from their place of formation by whirlwinds and hurricanes.

BIBL. Ehr. *Abhandl. d. Berl. Akad.* 1838.

PAP'PUS.—The free portion of the calyx of the Compositæ. It may be feathery, spiny, membranous, or hairy.

PAPULAS'PORA, Preuss.—A genus of Mucedines (Hyphomycetous Fungi), consisting of a decumbent articulate mycelium sending up erect pedicels bearing a cellular head, each cell supporting an oblong spore.

P. sepedonioides has been found on rice-paste.

BIBL. Berk. and Broome, *Ann. N. H.* 2. xiii. 462; Berk. *Crypt. Bot.* 305, fig. 69 *b*.

PAPY'RUS.—The pith of the stem of the *Papyrus antiquorum* (modern papyrus from *P. syriacus*), cut into slices, which are laid upon one another and pressed so as to form a compact stratum. Sections display the parenchymatous tissue more or less deformed by pressure.

PARACY'PRIS, Sars.—A genus of *Cypridæ* (Entomostraca), near *Aglaia* and *Potamocypris*. One British species, rather common, marine; also fossil in raised beaches, &c. (Brady, *Linn. Tr.* xxvi. 377.)

PARADOXOS'TOMA, Fischer.—A genus of *Cytheridæ* (Entomostraca). Valves thin, smooth, elongate, compressed, subovate or subtriangular; mouth simple, tubiform; five joints in the lower, six in the upper antennæ, the last very slender. Marine; 13 British species. *P. variabile* very common, fossil in raised beaches, &c. (Brady, *Linn. Tr.* xxvi. 456.)

PARAME'CIUM, Hill, Ehr.—A genus of Holotrichous Infusoria, family Colpodina.

Char. Body compressed, covered with cilia; no eye-spot; mouth lateral and without projecting cirri.

Several species, freshwater and marine.

P. aurelia (Pl. 31. figs. 56 and 57). Body cylindrical, ovate-oblong, rounded or obtuse at the ends, with an oblique longitudinal fold extending to the mouth. Length 1-120 to 1-100″; in vegetable infusions.

This common infusorium shows well the curious star-shaped contractile vesicles. Ehrenberg notices in it the periodical occurrence of small black crystalline particles at the anterior end. The depressions on the surface of the integument (Pl. 32. fig. 1) are distinctly seen in the dried animal; trichocysts are present.

P. chrysalis, E. (*Pleuronema crassum*, D. Pl. 32. fig. 37, undergoing division). Body oblong, cylindrical; oral cilia very long. Length 1-240″.

BIBL. Ehr. *Inf.* 349; Duj. *Inf.* 481; Stein, *Infus.*; Claparède et Lachmann, *Infus.* 265; Kent, *Inf.* 483.

PARAM'ONAS, Kt.—A genus of Flagellate Infusoria. Free, ovate or globular, one flagellum, a distinct mouth at its base. Four species, white, red, or green; freshwater. (Kent, *Inf.* 370.)

PARAPHY'SES.—The name applied to more or less delicate-jointed, hair-like filaments which occur in small numbers around and between the antheridia and archegonia of Mosses and Hepaticæ (fig. 23, p. 57, fig. 327, p. 388). The same term is applied to simple tubular, more or less clavate cells, occurring in large numbers among the spore-sacs (*asci* and *thecæ*) of the Ascomycetous Fungi and the Lichens (fig. 40, p. 78; fig. 398, p. 463; Pl. 37. figs. 6, 12).

PARAPONTEL'LA, Br.—A genus of Copepodous Entomostraca. *P. brevicornis*, marine. (Brady, *Copepoda, Ray Soc.* i. 68.)

PARASITES.—Under this head are in-

cluded a number of microscopic animals and plants infesting other animals and plants, and often nourished at the expense of their structures or juices. Almost every animal and plant is subject to parasites, both in the young and the adult state; and in some instances, the parasites are themselves infested by other parasites. The parasite may live on the surface of the parasitiphore or host, or within its tissues and in the cavities of its organs; hence the division of parasitic animals into epizoa and entozoa. The commonest parasites either feed upon the decaying external skin-tissues, or are nourished at the expense of the blood and fluids. In some remarkable instances, as in the cirripeds, the male appears to live parasitically upon the female; and in almost every case of parasitism there is a complicated life-cycle, often accompanied by strange adaptations and degenerations of form, so that often the parasite ultimately resembles but slightly its free and primitive form. Of the Animal Parasites, many are not microscopic, but the following sketch may be useful for reference. The chief portion belong to:—The CRUSTACEA, Order Siphonostoma, as *Caligus, Cecrops, Læmargus, Nicothoë*. The ARACHNIDA, Ord. Acarina, as *Sarcoptes*, the itch-insect; the Ixodea, or ticks; the Gamasea, on insects; *Trombidium*, the harvest-bug; the Hypoderidæ, in birds; the Phytoptidæ, in galls. The Insects, especially the Anoplura, as *Hæmatopinus, Pediculus* (the louse), and *Phthirius*; *Pedicinus*; and *Trichodectes*. The ENTOZOA, as *Tænia* (*Cœnurus, Cysticercus, Echinococcus*); *Distoma*, in the liver; *Bilharzia*, in the human blood-vessels, the ova in the urine in endemic hæmaturia and chyluria; the Nematodes, *Anguillula intest.* and *stercoralis*, and *Dochmius*, in tropical diarrhœa; *Sclerostoma syngamus* in poultry, producing the "gapes;" *Strongylus pergracilis* in the Grouse-disease. The Infusoria, *Opalina, Trichomonas*, &c.; and the GREGARINIDA, *Psorospermiæ* in mammals, and insects (PEBRINE).

These are described under the respective heads.

The Plants parasitic on animals chiefly belong to the class of FUNGI, and are tolerably numerous; but many of the forms which have been described are certainly not distinct plants. They will be most conveniently enumerated under the heads of the classes of animals infested.

Man and Mammalia.

On the Skin.—ACHORION *Schœnleinii* and PUCCINIA *favus*, on the hair and in the follicles, in favus. TRICHOPHYTON *tonsurans*, on the hair in plica polonica and favus; this appears to be a *Torula*-like growth, probably not a mature plant. *Tr.? sporuloides*, Rob., occurs in plica; and *Tr.? ulcerina*, Rob., in the pus of ulcers. *Microsporon Audouinii* occurs in the hair-follicles in porrigo decalvans; *M. mentagrophytes*, on the beard &c.; *M. furfur*, on the skin of the chest &c. in pityriasis versicolor. The occurrence of *Mucor mucedo* on the skin, and of an *Aspergillus* in the external conduit of the ear, must be regarded as accidental.

On the *mucous surfaces or in cavities.*—SARCINA *ventriculi* in the stomach; *Torula cerevisiæ* (?), ditto. Various species of LEPTOMITUS, which must be regarded as imperfect mycelial growths, found in almost all the cavities of the body. *Oidium albicans*, the fungus of aphtha, probably a peculiar condition of PENICILLIUM; *Leptothrix buccalis*, a filamentous growth constant between the teeth, probably some allied mycelium.

Birds.

Various species of ASPERGILLUS have been found in the lungs and air-sacs; their introduction would appear to be accidental. In the eggs of the common fowl, DACTYLIUM *oogenum* occurs not unfrequently, sometimes on the membrane of the yolk, sometimes on the outer membrane, just beneath the shell.—SPOROTRICHUM *bruneum*, Schenk, in the white of eggs, converting it into a brownish gelatinous mass.

Reptiles and Fishes.

On the skin of Tritons, as of Fishes, ACHLYA (*Saprolegnia*) is frequently extremely developed; other obscure forms are also enumerated by Robin. The same author describes the PSOROSPERMIÆ as Algæ allied to the Diatomaceæ; but they are pseudonaviculæ of GREGARINA.

Berkeley has recorded the occurrence in Denbighshire, on the scales of goldfish, of a lichen identical with one which is found on stones in neighbouring streams.

Insects

are subject to the invasion of various parasitic fungi, among the most remarkable of

which is the Muscardine of the Silk-worm, Botrytis *bassiana*, which sometimes occasions enormous loss to the silk-cultivators. This fungus grows in or upon any part of the silk-worm, *Bombyx mori*, in its larva, chrysalis, and imago forms. It is not fully developed until after the death of the insect; but if the spores penetrate the body of a living specimen and this is placed in a damp and confined atmosphere, the germination takes place, and a development of the fungus ensues, which destroys the tissues and organs, finally causing death. It has been developed on many other Lepidoptera which have been inoculated with it; and even the larvæ of certain Coleoptera take it. It is very common to find flies in autumn infested with a fungus, a kind of muscardine of flies: this belongs to the genus Sporendonema; its mycelial filaments ramify in the interior of the body, and emerge at the articulations of the segments of the abdomen to bear fruit, killing the fly. A number of so-called genera of Fungi and Algæ have been described by Robin and Leidy as occurring in the intestines &c. of insects: these appear to us to be imperfect organisms (see Enterobryus, Arthromitus, Leptothrix, Cladophytum). Several species of *Cordyceps* infest the larvæ of insects, the mycelium destroying them and gradually completely displacing the internal organs, while the skin retains its shape and dries; the fruit subsequently breaks out from the anterior or posterior extremity (see Sphæria). Some species of Isaria, described as parasites, grow upon dead insects; but these are mere conditions of different species of *Cordyceps*.

The microscopic vegetable parasites of Plants

are very numerous, all belonging to the class of Fungi. Much confusion exists in many works between the true parasites and mere epiphytes; and it is sometimes very difficult to draw any line of demarcation. Among the undoubted parasites are all the genera and species of the family Uredinei, together with a large portion of the other genera of Coniomycetes and the Ascomycetous forms to which they mostly belong. Among the Hyphomycetes may especially be cited the genus Peronospora, *P. infestans* being the potato-fungus. Fusisporium, Oidium, &c. form destructive mildews; and among the Ascomycetes, the Erysiphæ, and especially their mycelia (commonly forming spurious *Oidia*), are well-known pests. Further particulars are given under Potato-Fungus (*Botrytis infestans*), Vine-Fungus, and Blight. The organisms described as Unicellular Algæ, under the names of Chytridium and *Pythium*, are parasitic on Confervoids.

Bibl. Robin, *Végét. Parasit.*; Bærensprung, *Ann. N. H.* xii.; Siebold, *Wagner's Hand. d. Phys.*; Hannover, *Müller's Arch.* 1842; Bennett, *Ed. Phil. Tr.* xv.; Archer, *Qu. Mic. Jn.* 1872, 366; Cobbold, *Parasites*; Leuckart, *Mensch. Parasit.* 1881; Murie, *Mn. M. Jn.* vii. 149; Maddox, *Mic. Tr.* 1866; Beneden, *Schmarotzer*, 1876; Hallier, *Phytopathol.* 1868; Kaltenbach, *Pflanzenfeinde (Insects)*, 1872; Giebel, *Epizoa (Insects)*, 1874; Dounon, *Par. diar. Cochin-China*; Gurlt, *Arch. Naturgesch.* 1878, 162; Hartig, *Pflanzen Kr. (Fungi)*, 1880; Frank, *Krankh. Pfl. (Fungi)*, 1880; Heller, *Schmarotzer*, 1880; Mégnin, *Paras.* 1880; Ormerod, *Injurious Insects*, 1881; Cohn, *Paras. Algæ*, Beiträge, i. 87; Küchenmeister, *Parasiten*, 1881; Bollinger, *Pilzkrankh. nied. und höh. Thiere*, *Bot. Centralblatt*, ii. 274 (*Jn. Mic. Soc.* 1881, 492); Hallier, *Zeitschr. Paras. Kunde.*

PAREN'CHYMA. See Tissues, Vegetable.

PARKE'RIA, Carpenter. — A large spheroidal Arenaceous Foraminifer, attaining 3 inches and more in diameter, and consisting of a chambered conical centre-piece (primordial chamber-cone) surrounded by numerous concentric lamellæ and their interspaces, traversed and connected by radial tubes, all of cancellated (labyrinthic) structure. Fossil in the Greensand.

Bibl. Carpenter, *Phil. Trans.* 1869, 721.

PARKE'RIA, Hooker, = Ceratopteris.

PARME'LIA, Ach.—An extensive genus of Parmeliaceæ, characterized by the spreading, lobed, foliaceous thallus, with orbicular apothecia fixed by a central point beneath; spores simple; growing upon trees, palings, rocks, stones, walls, &c. The species with bilocular spores form the genus *Physcia*. *P. parietina*, the yellow wall-lichen, is one of the commonest plants of this family, and furnishes a ready means of observing the structure both of the apothecia and the spermogonia (Pl. 37. figs. 1–3).

Bibl. Hook. *Br. Fl.* ii. pt. 1. 202; *Engl. Bot.* pl. 194; Schærer, *Enum. Lich. Europ.*; Tulasne, *Ann. Sc. Nat.* 3. xvii. 66, 137; Leighton, *Lich. Flora*, 114.

PARMELIA'CEÆ.—A family of open-fruited Lichenaceous Lichens, bearing sessile shields, the borders of which are formed by the surface of the thallus. This family corresponds nearly to the series Ramalodei, Phyllodei, and Placodei, of the family Lichenacei in Leighton's *Brit. Lich. Flora.*

British Genera.

* *Apothecia at first veiled, thallus horizontal*: Peltigeri.

Peltigera. *Thallus* foliaceous, leathery or membranous, spreading, lobed, with woolly veins beneath. *Apothecia* somewhat circular, adnate on the upper side of the lobules of the thallus, with a border formed by this.

Nephroma. *Thallus* foliaceous, leathery or membranous, spreading, lobed, naked or hairy beneath. *Apothecia* circular or reniform, adnate on the underside of the lobules of the thallus, with a border formed by the latter.

Solorina. *Thallus* leathery, membranaceous, veined or fibrillose below. *Apothecium* suborbicular, affixed to the upper surface of the central lobes of the thallus; veil finally forming an evanescent margin.

** *Apothecia at first closed, thallus horizontal*: Euparmeliacei.

Sticta. *Thallus* foliaceous, leathery-cartilaginous, spreading, lobed, free and downy beneath, with little cavities or hollow spots, often containing a powdery substance. *Apothecia* beneath formed of the thallus, to which they are appressed and fixed by a central point, the disk coloured, flat, surrounded by an elevated thalline border.

Parmelia. *Thallus* foliaceous, membranous or leathery, spreading, lobed and stellated or laciniated, more or less fibrous beneath. *Apothecia* circular, formed by the thallus, fixed by a central point, disk concave, coloured, with an inflexed margin from the thallus.

Urceolaria. *Thallus* uniform, crustaceous. *Apothecia* urceolate, somewhat immersed, the thalline border somewhat distinct.

Lecanora. *Thallus* crustaceous, spreading, flat, adnate and uniform. *Apothecia* circular, thick, sessile and adnate; disk plano-convex, the border thickish, formed of the crust, and of the same colour.

Physcia. *Thallus* cartilaginous, branched and laciniated, the segments free, generally grooved beneath, the margins frequently ciliated. *Apothecia* circular, peltate, formed of the thallus, the disk coloured and surrounded by an inflexed thalline margin.

*** *Apothecia open from the first, thallus mostly centripetal, vertical or sarmentose, without any hypothallus*: Usnei.

Cetraria. *Thallus* foliaceous, cartilagineo-membranous, ascending or spreading, lobed and laciniated, smooth and naked on both sides. *Apothecia* circular, obliquely adnate to the margin of the thallus, the lower portion being free (from the thallus); disk coloured, plano-concave, with an inflexed thalline border.

Roccella. *Thallus* cartilaginous, leathery, rounded or flat, branched or laciniate. *Apothecia* circular, adnate to the thallus, disk coloured, plano-convex, with a thalline border, at length thickened and elevated, and covering a black powder concealed within the substance of the thallus.

Ramalina. *Thallus* cartilaginous, generally branched and laciniated, somewhat shrubby, generally bearing powdery warts, cottony and compact within. *Apothecia* circular, shield-shaped, stalked and peltate, flat, bordered, entirely formed of the substance of the thallus, and mostly of the same colour.

Cornicularia. *Thallus* cartilaginous, branched, subcylindrical, fistulose, or nearly solid and cottony within. *Apothecia* circular, terminal, obliquely peltate, entirely formed of the substance of the thallus, at length convex, more or less bordered and often toothed.

Evernia. *Thallus* somewhat crustaceous, branched and laciniated, angled or compressed, cottony within. *Apothecia* circular, shield-shaped, sessile, with the disk concave, coloured, and an inflexed border formed by the thallus.

Usnea. *Thallus* somewhat crustaceous, rounded branched, generally pendulous, with a central thread. *Apothecia* circular, terminal on processes of the thallus, peltate, nearly of the same colour, mostly without a raised border, but ciliated at the margins.

BIBL. See the genera.

PASTE, EELS IN. See ANGUILLULA.

PATELLI'NA, Will.—A genus of Hyaline Foraminifera, of the Rotaline family.

Trochoid, formed of a low cone of subspiral, semiannular, and annular chambers, divided into chamberlets. Sometimes incrusted with small cells externally, and

always having the hollow face coated or filled up with superimposed chamberlets, forming a columnar chamber-structure.

British species, *P. corrugata* (Pl. 24. fig. 8), rare: abundant in tropical seas; and of larger size in some Cretaceous and Tertiary strata.

Bibl. Williamson, *Rec. For.* 46; Carter (*Conulites* and *Orbitolina*), *Ann. N. H.* 3. viii. 331, 457, 459; Carpenter, *Introd. For.* 299.

PAVONI'NA, D'Orb.—A Hyaline Foraminifer, compressed and flabelliform; chambers concentric, the last widest, with numerous marginal apertures. It is a flat Bigenerine *Textularia*. Madagascar, Pacific, and West Indies.

Bibl. Brady, *Ann. N. H.* 4. xix. 105; *Qu. Mic. Jn.* n. s. xix. 68.

PAXIL'LUS, Fr.—A genus of Agaricini (Hymenomycetous Fungi) with the margin of the pileus involute, the gills decurrent, anastomosing, and separable from the pileus and without any trama. *Paxillus involutus* is a very common species; and to this the characters of the genus more especially apply. *P. pannoides* occurs on sawdust in cellars &c., and is closely allied to *Merulius*.

Bibl. Fr. *Gen. Hym.* 8; Berk. *Outl.* t. 12. fig. 5; Cooke, *Handb.* 194.

PEARLS.—These well-known bodies are formed as secretions from the mantle of bivalve mollusks, the best being obtained from the Ceylon pearl-oyster or mussel (*Avicula margaritifera*). They occur naturally from the irritation produced by particles of sand accidentally confined between the mantle and the shell; and they are produced artificially by wounding the mantle with pieces of iron wire, &c. Their structure agrees with that of the shell of the animal in which they are formed. Sometimes they consist entirely of nacre or pearly matter, arranged in close concentric layers; at others, the interior exhibits the prismatic structure of shell. When acted upon by a dilute mineral acid, the lime-salt is removed from the organic cast of the original, which is left. They are sometimes found fossil.

See Shell.

Bibl. Hague and Siebold, *Siebold & Köl-liker's Zeitschr.* viii. 439 & 445; Carpenter, *Microscope.*

PEB'RINE is the name of a disease which for the past twenty years has raged amongst the silkworms in France. In 1853, the weight of cocoons produced in that country was 26,000,000 of kilogrammes; in 1865 it had fallen to 4,000,000. The black spots which cover the larvæ are a frequent outward sign of the disease; hence the name *pébrine*, first applied to the plague by Quatrefages. It also declares itself in the stunted and unequal growth of the worms, in the languor of their movements, in their fastidiousness as regards food, and in their premature death. The cause of the disease is the presence in the internal economy of the larvæ of *Gregarinida*; their number is often enormous. They take possession of the intestinal canal, and spread thence through the rest of the body. In particular, the silk-secreting organs, instead of being filled with the clear viscous liquid of the silk, are packed to distention by these corpuscles. Pasteur in 1865 made out the fact that they might exist in an incipient condition in the eggs and larvæ, although it might be impossible to detect them. In the moths, if either egg or larva from which they come should have been at all stricken, the corpuscles infallibly appear, and there is no difficulty in detecting them. In eradicating the disease, Pasteur, therefore, showed that it was of the greatest importance to secure eggs from healthy moths, since the healthy appearance of the eggs themselves was not sufficient to secure immunity. The larvæ issuing from the eggs of perfectly healthy moths may themselves become infected through contact with diseased larvæ, or through germs mixed with the dust of the rooms in which the silkworms are fed.

Bibl. Pasteur, *Maladie des vers à soie*; Tyndall, *Nature*, 1870; Balbiani, *Jn. Anat.* 1866, 599; Robin, *Micr.* 948.

PECTINATEL'LA, Leidy.—A genus of freshwater Polyzoa, order Hippocrepia, family Plumatellidæ.

Char. Zoary massive, gelatinous, fixed, investing; orifices arranged in irregular lobate areolæ upon the free surface; ova lenticular, with a ring and marginal spines.

P. magnifica. Philadelphia.

Bibl. Leidy, *Proc. Ac. Philadelphia*, 1851; Allman, *Freshwater Polyzoa*, 81.

PEDA'LION, Hudson.—A genus of Rotatoria, family Hydatinæa. *P. mirum* has the trochal disk very large, and resembles *Triarthra longiseta*. The males are very small, and deficient in most of the inrnal organs; freshwater.

Bibl. Hudson, *Mn. Mic. Jn.* 1871, 1872; *Qu. Mic. Jn.* 1872, 333; Lankester, *Qu. Mic. Jn.* 1872, 338.

PEDIAS'TRUM, Meyen.—A genus of Desmidiaceæ (Confervoid Algæ).

Char. Cells aggregated into a usually circular, minute disk or flattened star, and generally arranged either in a single or in two or more concentric series; marginal cells bipartite on the outside.

Ralfs describes eleven British species. Interstices of the cells usually hyaline, but in *P. selenæum* these are greenish.

Braun divided the genera into four subgenera, which include twenty-nine forms more or less worthy of being considered genera.

P. Boryanum (Pl. 14. fig. 48). Cells arranged in one or more circles around one or two central ones; marginal cells gradually tapering into two long subulate points; notch narrow. Diameter of outer cells 1-2730 to 1-2200″.

P. granulatum (Pl. 14. fig. 49). Cells six, granular or punctate on the surface; lobes of marginal cells tapering. Diameter of outer cells 1-1850″.

The method of reproduction is noticed under DESMIDIACEÆ, p. 244.

BIBL. Ralfs, *Br. Desmid.* 180; Braun, *Rejuv., Ray. Soc.* 1853, pls. 3 & 4; *Alg. Unicell. Gen. Nova*, 64; Rabenh. *Aly.* iii. 69.

PEDICELLA'RIÆ. See ECHINODERMATA.

Pl. 45. fig. 3 represents a pedicellaria from the common starfish; the stalk is not figured.

The bird's-head processes of the Polyzoa (POLYZOA) are analogous organs.

PEDICELLI'NA, Sars.—A genus of Ctenostomatous Polyzoa, family Pedicellinidæ.

Char. Those of the family.

Bodies globose, with a circle of short tentacles, curled inwards and not retractile; placed at the ends of erect slender stalks springing from a creeping adherent fibre. 3 species.

BIBL. Johnston, *Br. Zooph.* 381; Allman, *Polyzoa, Ray Soc.*, 19, note; Hincks, *Polyz.* 564.

PEDICELLINI'DÆ.—A family of Polyzoa, containing the single genus PEDICELLINA.

PEDICI'NUS, Gerv.—A genus of Pediculidæ; with the antennæ 3-jointed, the fourth and fifth being fused with the third, the head elongate; the legs all scansorial; abdomen broad. On Quadrumana. (Mégnin, *Paras.* 76.)

PEDIC'ULUS, L.—A genus of Anoplurous Insects, of the family Pediculidæ.

Char. Legs all scansorial or prehensile; thorax large, not constricted from the abdomen, which has seven segments; antennæ five-jointed; mouth with a fleshy rostrum.

The species are human lice. The colour varies according to that of the skin of the people they inhabit; being darker in the dark tribes.

Rostrum retractile, concealed beneath the head, forming a soft tubular sheath dilated at the end, where it is furnished with a double row of hooks, and containing a horny tube formed of four setæ.

P. capitis. Ashy-white, thorax elongated, quadrate, abdomen ovate, laterally lobed, segments blackish at the margin. Length of male, 1-16″; of female, 1-8″.

P. vestimenti, body or clothes' louse (Pl. 35. fig. 3). Dirty white, elongato-ovate; head much produced; thorax contracted in front; abdomen with the segments indistinctly indicated. Length about 1-8″.

P. tabescentium, distemper-louse. Pale yellow; head rounded; antennæ long; thorax large and quadrate; abdomen large, the segments intimately united. Doubtfully British.

The extraordinary annoyance stated to have been produced by these vermin, has arisen from the want of washing and purification of woollen garments.

See PHTHIRIUS.

BIBL. Denny, *Anoplur.*; Murray, *Ec. Ent.* 391; Schiödte, *Ann. N. H.* 1860, xvii. 213; Mégnin, *Paras.* 74; Piaget, *Pediculi.* 1880.

PELARGO'NIUM. See POLLEN, RAPHIDES, and HAIRS.

PELECI'DA, Duj., = *Loxodes*, Cl. & L.

P. rostrum (Pl. 31. fig. 39) = *Loxodes rostrum.*

PELLÆ'A, Lk.—A genus of Pterideæ (Polypodiaceous Ferns). Many species, tropical. (Hooker, *Syn.* 144.)

PEL'LIA.—A genus of Pelliæ (frondose Hepaticæ). *P. epiphylla* (fig. 556) is not uncommon in damp shady places, by springs and wells, where it grows rapidly. Its pedicels are silvery-white, the capsules pale brown; and when the valves are fully expanded, the elaters form an elegant tuft in the middle. The character of the frond varies somewhat according to the degree of moisture of the habitat. The forms called *longifolia* and *furcigera* are now considered to constitute a distinct species, *P. calycina.*

BIBL. Hooker, *Br. Jung.* pl. 47; *Br.*

Fig. 556.

Pellia epiphylla.

Magnified 2 diameters.

Flora, ii. pt. 1. 130; Endlicher, *Gen. Plant. Supp.* i. Nos. 472–5; Ekart, *Syn. Jung.* 63, pls. 7 & 13; *Eng. Bot. Supp.* pl. 2873.

PELLIE'Æ.—A tribe of Liverworts or Hepaticæ, nearly allied to the Jungermannieæ in the character of the fructification, but having a lobed thalloid frond, traversed by a mid nerve, from which the fruit-stalks arise.

British Genera.

Blyttia. Fructification emerging from the end of the rib below the apex of the frond, at length dorsal. Perichæte 4–5-parted; lobes torn. Perigone herbaceous, tubular, the mouth denticulated. Archegones eight to twenty. Epigone persistent, torn at the summit. Sporange 4-valved. Antheridia dorsal, placed on the rib, covered by dentate incumbent leaflets.

Petalophyllum. Fructification from the upper surface of the plaited frond. Perichæte broad, bell-shaped and toothed. Perigone wanting. Epigone concealed in the perichæte. Sporange bursting into irregular laciniæ. Elaters often branched.

Fossombronia. Fructification emerging from the end of the rib below the apex of the frond, at length dorsal. Perichæte obconic bell-shaped, the mouth crenate or dentate. Perigone wanting. Archegones few. Epigone persistent, torn at the summit. Sporange circumscissile. Antheridia dorsal, situated on the rib, naked.

Metzgeria. Fructification emerging from the ventral side of the midrib of the frond, Perichæte ventricose, at length bipartite. Perigone none. Archegones few. Epigone persistent, torn at the summit. Sporange four-valved. Antheridia ventral, placed on the rib, covered by incumbent dentate leaflets.

Aneura. Fructification emerging from the ventral side, near the margin of the frond. Perichæte short, lobed or torn. Perigone wanting. Archegones few. Epigone persistent, torn at the summit. Sporange four-valved. Antheridia immersed in the back of special lobes of the frond.

Pellia. Fructification emerging from the dorsal side of the frond. Perichæte short, somewhat cup-shaped, the mouth lacero-dentate. Perigone wanting. Archegones several. Epigone membranous, accompanied by a few sterile archegones, at first, at the lower part. Sporange four-valved. Antheridia immersed in the surface of the frond.

Blasia. Fructification at first immersed in the rib of the frond, then emerging from the apex. Perichæte and perigone wanting. Epigone membranous, with few sterile archegones, at first, scattered toward the lowest part. Sporange four-valved. Antheridia immersed in the rib of the thallus, more prominent below, and covered by little dentate scales.

Targionia. Fructification sessile, inferior, solitary and terminal to the frond. Perichæte two-valved, splitting vertically. Perigone wanting. Epigone delicate, persistent, investing the sporange until maturity, sometimes evanescent above. Sporange bursting by an irregular slit, or into fragments. Antheridia immersed in the rib of the frond below, covered by papillæ.

PELOMYX'A, Greef.—A genus of Amœbæa (Rhizopoda).

This freshwater organism forms large brown amœboid masses, with lobose hyaline pseudopodia. The ground-substance contains nuclei, hyaline homogeneous highly refractive, and delicate rod-like bodies. It gives rise to swarms of minute Amœbæ, which become developed into flagellate free-swimming organisms.

BIBL. Greef, *Schultze's Archiv*, 1873; *Qu. Mic. Jn.* 1874, 97.

PELONÆ'A, Forbes.—A genus of Tunicate Mollusca, of the family Pelonæadæ.

Char. Unattached; feet cylindrical; orifices without rays, on two equal approximate warty eminences at the anterior end. They live buried in mud. Two species;

P. corrugata. Test deep brown, much elongated, rudely wrinkled transversely.

P. glabra. Test greenish yellow, smooth, pilose, shorter than the last. See TUNICATA.

BIBL. Forbes and Hanley, *Br. Moll.* i. 43.

PE'LOPS, Koch (*Acarina*). — Differs from *Oribata* in the hairs on the vertex being flat or spatula-shaped. (Murray, *Ec. Ent.* 218; Michael, *Jn. Mic. Soc.* 1879, 237.)

PELOPSI'NA, Brady.—A genus of Arenaceous Foraminifera, one- or many-chambered; walls thick, composed of mud, with a long chitinous neck. Living, South Seas. (Brady, *Qu. M. Jn.* 1879.)

PELTIDE'A, Hoffm.,=Species of PELTIGERA and STICTA.

PELTID'IUM=ALTEUTHA.

PELTIG'ERA, Willd. — A genus of Parmeliaceous Lichens, characterized by a foliaceous, usually leathery thallus, with woolly veins beneath; the suborbicular shield-like apothecia arising on the upper sides of the lobules.

P. canina, a large Lichen, is extremely common on the ground among moss in woods. Two or three nearly allied species are separated from this by most authors, but with questionable propriety. Three or four others are subalpine.

BIBL. Hook. *Br. Fl.* ii. pt. 1. 218; *Eng. Bot.* 2229; Leighton, *Lich. Flor.* 101.

PENEROP'LIS, Lamk.—A genus of Porcellaneous Foraminifera.

Broad, complanate, and ear-shaped (*P. pertusus*, Pl. 23. fig. 11), or narrow, subcylindric, and crosier-like (*Spirolina*) (*S. austriaca*, Pl. 23. fig. 12); striated. The primordial double chamber is succeeded by curved chambers in one direction; and as these vary in transverse extent, sometimes to even three fourths of a circle, the shell takes different shapes. The aperture is single and lobulate in the early chambers; cribrate in the narrow, branched in the nautiloid forms (*Dendritina*); and divided into rows of holes, often tubular, in the outspread varieties. Living in the Mediterranean and warm seas only; fossil in the Tertiaries.

BIBL. Williamson, *Rec. For.* 45; Parker and Jones, *Ann. N. H.* 3. v. 179; Carpenter, *Phil. Tr.* 1859, 2; *Foram.* 84.

PENICIL'LIUM, Link.—A genus of Mucedines (Hyphomycetous Fungi), of which the species *P. glaucum* is at once one of the most frequent and the most puzzling plants of the class. This fungus is the commonest of the constituents of the greenish or bluish mould formed on decaying vegetable substances of all kinds, especially on semifluid or liquid matters. On the surface of liquids it forms a kind of dense pasty crust, slimy on the lower surface, and coloured and pulverulent (bearing spores) above. When the upper fertile layer is examined under the microscope, it is found to consist of pedicels terminating in a repeatedly but shortly bifurcated pencil, each ultimate branch of which bears a moniliform row of spores. The ramification of the pedicels is not distinctly represented in fig. 557; but the appearance of the spores is characteristic; and the ramifications of the sporophores are scarcely perceptible in examples growing on dryish substances. The mode of attachment of the spores is shown in figs. 15 and 16 of Pl. 26. The mycelium consists of interwoven articulated filaments, most extensively ramified. The spores appear whitish, yellowish, greenish, or bluish, according to age: under the microscope they appear opaque when mature.

So far there is little difficulty about the history of these plants; and if the spores of the above form are sown on a glass slide, kept moist with an organic liquid, they will germinate and ramify, and under favourable circumstances bear thin penicillate tufts of spores at points which emerge from the nutrient liquid. But this same fructification of *P. glaucum* presents itself invariably under certain circumstances associated with the vinegar-plant and the yeast-plant, toward the close of the ordinary development of these fungi. In common with most observers, we find that the exhaustion of the saccharine matrix of the vinegar-plant is followed in all cases by the appearance of crusts of *Penicillium*-mould on the upper surface, whence it would appear that the vinegar-plant was only the mycelium of *Penicillium*. It was asserted, moreover,

Fig. 557.

Penicillium.
A fertile plume with pencils of spores.
Magnified 150 diameters.

many years ago, by Turpin, that *P. glaucum* is the last term of the growth both of the true yeast-plant (*Torula Cerevisiæ*) and of the milk-yeast (*Oidium lactis*). We have found the gelatinous crusts of the vinegar-plant to contain structures which represent *Torula* and *Oidium*, and to grow like them; and we have also observed, in repeated experiments, that beer allowed to stand until sour, at first appears clothed with a whitish mealy collection of minute vesicles, representing the ultimate stage of *Torula*, and subsequently this gradually gave place to gelatinous matter, which at length covered the whole surface with a tough film, and fruited as *Penicillium glaucum*. Hence it would appear that the yeast-fungus also is merely a vegetative form of *Penicillium* developed under peculiar conditions. This, however, has been actually proved by Berkeley and Hoffman (see "Yeast," in Black's 'Encyclopedia of Agriculture'). More is said on this point under VINEGAR-PLANT and YEAST.

One of the species has become famous on account of its extremely rapid occurrence in Paris on the "pain de munition," where the spores must have undergone a degree of heat equal to that of boiling water.

Several species are enumerated; and we have given under the separate head of COREMIUM a form which is merely a confluent growth of *Penicillium*, producing a compound pedicel.

P. glaucum, Grev. Mycelial filaments form a crust-like web, spores green or bluish. Greville, *Sc. Crypt. Fl.* pl. 58. fig. 1.

P. crustaceum, Fries. Extremely common.

P. candidum, Link. Mycelial filaments woven together, spores white. (Distinct?)

P. sparsum, Grev. Mycelium lax, spores white. *Sc. Crypt. Fl.* pl. 58. fig. 2. Perhaps not different from the last.

P. fasciculatum, Sommer. Mycelium scarcely developed filaments all fertile, trifid at the apex, spores glaucescent.

P. subtile, Berk. Extremely minute, mycelium creeping, fertile filaments erect, simple or ternate; chains of spores few, spores broadly elliptical. *Ann. N. H.* vi. pl. 14. fig. 25.

P. roseum, Link. Mycelium effused; fertile filaments slightly branched, spores rose-colour.

One species (*P. curtipes*) has been found in amber.

BIBL. Berk. *Hook. Br. Flor.* ii. pt. 2. 344; *Ann. N. H.* i. 262, vi. 437, 2. vii. 102; Greville, *loc. cit.*; Fries, *Syst. Myc.* iii. 407; *Sum. Veget.* 489. See also YEAST and VINEGAR-PLANT.

PE'NIUM, Bréb.—A genus of Desmidiaceæ.

Char. Cells single, entire, elongated, straight, and slightly or not at all constricted in the middle.

Sporangia round or quadrangular, smooth, not spinous.

At each end of the cells is a rounded space containing moving molecules.

Several British species (Ralfs).

P. Brebissonii (Pl. 14. fig. 36). Cells smooth, cylindrical, ends rounded, transverse median band inconspicuous. Length 1-640 to 1-400".

Common. Sporangium at first quadrate, but finally orbicular; conjugating cells persistent, or remaining permanently attached to the sporangium.

P. margaritaceum (Pl. 14. fig. 37, empty cell). Cells cylindrical or fusiform, with rounded truncate ends, and covered with pearly granules in longitudinal rows. Length 1-160".

BIBL. Ralfs, *Desmid.* 148; Archer, *Qu. Mic. Jn.* 1864, 179, 1867, 183; Hassall, *Alg.*; Rabenh. *Alg.* iii. 119.

PENNAT'ULA, Cuv. (Sea-pen). — A genus of Alcyonaria (Zoophytes).

The spicula form interesting microscopic objects.

PENTHALEUS, Koch. — A genus of Trombidina (Acarina). Somewhat elongate; anterior legs rather long and slender; femora of hind legs thickened. *P. hæmatopus.* (Koch, *Uebers.*; Murray, *Ec. Ent.* 121.)

PENTHALO'DES, Murr., = *Megamerus ovalis.*

PEPLONYS'SUS, Kol. — A genus of Sarcoptidæ (Acarina). 2 species; yellowish-brown; on *Nycteris* and *Rhinopoma*; Egypt. (Kolenati, *Sitz. Ak. Wien*, 1858, 74; Murray, *Ec. Ent.* 323.)

PEPPER.—Black pepper consists of the berries of *Piper nigrum*; white and decorticated pepper of the same berries with the outer part of the coats removed. The cellular tissues of the several lamellæ of the husk, and of the albumen or body of the seed, are tolerably characteristic (Pl. 2. fig. 12), and may be known by their appearance under the microscope from the fragments of linseed, mustard, &c. with which peppers are sometimes adulterated. White pepper is fraudulently reduced with flour, which

may be detected by the starch-granules—those existing in pepper itself being exceedingly minute particles; the same remark applies to rice and pea-flour, &c. Excessive quantities of the husk-tissue in black pepper denote that the refuse of the decorticated white peppers has been added. (See also CAYENNE.)

BIBL. Pereira, *Mat. Medica*; Hassall, *Food and its Adulterations*, 42.

PERACAN'THA, Baird.—A genus of Entomostraca, of the order Cladocera, and family Lynceidæ.

Char. Side view of shell oval, the lower and posterior portion with an acute projection directed backwards and upwards, and, as well as the upper extremity of the anterior margin, beset with strong hooked spines; beak sharp, curved downwards.

P. truncata (Pl. 19. fig. 31). Superior antennæ conical; inferior short, the anterior branch with five setæ, one from first, one from second, and three from last joint; posterior branch with three setæ from the last joint only; intestine convoluted, with one turn and a half; ova two; freshwater.

BIBL. Baird, *Brit. Entom.* 136.

PERANE'MA, Duj.—A genus of Flagellate Infusoria, family Euglenia.

Char. Form variable, globular, or inflated posteriorly and narrowed in front, where it becomes prolonged into a long flagelliform filament; movement slow, uniform, forwards.

P. globulosa (Pl. 31. fig. 59). Body almost globular, more or less drawn out anteriorly, with oblique wrinkles on the surface; freshwater; length 1-1400″.

BIBL. Dujard. *Inf.* 353; Pritchard, *Inf.* 545.

PERANE'MA, Don = SPHÆROPTERIS.

PERFORATA, Carpenter. — The Division of Foraminifera that possess a vitreous or hyaline shell perforated by tubular openings for the exit of pseudopodia.

BIBL. Carpenter, *Introd. Foram.* 149.

PERICHÆ'NA, Fr.—A genus of Myxomycetes, consisting of little rounded membranous sacs of brownish or yellowish colour, generally splitting all round (transversely), and discharging yellow spores and (few) free and elastic filaments. The commonest (*P. populina*), yellowish and about as large as a mustard-seed, occurs on fallen poplar trees; two others occur in fir-plantations.

BIBL. Berkeley, *Hook. Br. Fl.* ii. pt. 2. 321; Fries, *Syst. Myc.* 190; *Sum. Veget.* 459; Greville, *Crypt. Flora*, 252.

PERICO'NIA, Tode.—A genus of Dematiei (Hyphomycetous Fungi), characterized by a stem composed of fasciculate compacted threads. Head globose; spores fixed on the free apices of the threads. It is analogous to *Pachnocybe*. Tulasne states that it is merely a conidiiferous form of some *Sphæria*. Two species occur in this country.

P. glaucocephala, Cd.; on decayed linen.

P. calicioides, B.; on dead herbaceous stems.

BIBL. Fries, *Summa Veg.* 168; Berk. & Broome, *Ann. N. H.* 2. v. 165; Tulasne, *Ann. Sc. Nat.* 4. v. 109; Cooke, *Handb.* 565.

PERIDERM. See BARK.

PERIDER'MIUM, Lk. — A genus of Uredinei (Hypodermous Fungi), distinguished from ÆCIDIUM by the sac-like perithecium bursting irregularly, as if by a circumscissile dehiscence. The type of this genus is *P.* (*Æcid.*) *Pini*, found on the leaves and bark of Scotch Firs. The spores are covered with very numerous small tubercles. See UREDINEI.

BIBL. Berk. *Br. Fl.* ii. pt. 2. 374; Tulasne, *Ann. Sc. Nat.* 4 sér. ii. 176, pl. 10; De Bary, *Brandpilze*, 1853, 72.

PERIDINI'NA. — An Order of Cilioflagellate Infusoria (see p. 422).

PERIDIN'IUM.—A genus of Peridinina (Cilio-flagellate Infusoria).

Char. Body with a transverse groove, the two portions of the facetted lorica nearly equal.

Those species with a horn-like process, are sometimes separated as *Ceratium*.

P. fuscum (Pl. 31. fig. 11). Brown, not luminous, carapace ovate, slightly compressed, smooth, acute in front, rounded behind; freshwater; l. 1-430 to 1-290″.

P. (*C.*) *tripos* (Pl. 31. fig. 12). Yellowish, splendidly phosphorescent; carapace urceolate, broadly concave, mouth with three horns, two very long, frontal, and recurved, the third posterior and straight; marine; length 1-140″.

Several other species. See GLENODINIUM.

BIBL. Ehr. *Inf.* 262; Duj. *Inf.* 374; Allman, *Micr. Jn.* iii. 24; Clap. et Lach. *Etudes*, 403; Clark, *Ann. N. H.* 1865, xvi. 270; Kent, *Inf.* 447.

PERIGLISCHRUS, Koch. See PTEROPTUS.

The species adhere by the margin of the body all round.

PERIGONIMUS, Sars.—A genus of Atractylidæ (Hydroid Zoophytes).

Differs from *Atractylis* in the simple fixed spore-sacs being medusiform.

On other marine zoophytes, shells, &c.

Bibl. St. Wright, *Pr. Roy. Soc. Edin.* 1857, 1858; *Ann. N. H.* 1861, 130; Alder, *Trans. Tynes. F. C.* v. 230; Allman, *Ann. N. H.* 1863, 1864; Hincks, *Hyd. Zooph.* 89.

PERI'OLA, Fries.—*P. tomentosa*, Fr., described as a Sclerotioid Fungus, is an obscure, irregular, fleshy body, with a white villous surface, found growing on potatoes. It is probably the early form of some unascertained species of fungus. This was characteristic of those forms of potato-rot which were known before the introduction of the *Peronospora*.

PERIP'TERA, Ehr.—A genus of Diatomaceæ.

Char. Frustules single, compressed; valves dissimilar, one being simply turgid, the other winged or furnished with horns; horns sometimes branched and attached to the extreme margin. Fossil.

Valves not areolar nor punctate under ordinary illumination. America and Bermuda.

P. chlamidophora (Pl. 50. fig. 41); *P. tetracladia* (Pl. 18. fig. 66); *P. capra* (Pl. 18. fig. 67).

Bibl. Ehrenb. *Ber. Berl. Ak.* 1844, 263; Kütz. *Sp. Alg.* 25.

PERISPIRA, St.—A genus of Holotrichous Infusoria. Free, ovate; mouth anterior; oral cilia extending spirally towards the posterior end.

P. ovum; green, = *Hoplophrya ovum*? (Kent, *Inf.* 511.)

PERISPORIA'CEI.—A family of Ascomycetous Fungi, mostly epiphytic and of small size, characterized by producing floccose common receptacles (mostly) radiating from a point, forming patches upon leaves, &c., in the centre of which are developed somewhat globular perithecia of obscure cellular structure, persistent, bursting at the summit, filled densely with subgelatinous, scarcely diffluent gelatine; sporidia produced in asci, subsequently often effused, simple, free, and mixed with the gelatine in the centre of the perithecium. The mycelia of these plants, bearing conidial structures, have been described as distinct fungi, for example those of *Erysiphe* as *Oidia*, &c. See Erysiphe. Eurotium probably belongs here. British Genera:

Lasiobotrys. Perithecium fleshy-horny, globular, naked, collapsing at the summit.

Capnodium. Perithecium fleshy, clavate, double (the outer cellular, interior hyaline), mucilaginous, opening by a fringed mouth; asci containing about six spores in two rows.

Erysiphe. Perithecium membranous, closed at first, afterwards open, supported on a persistent radiating mycelium formed of continuous filaments bifid at their ends. Asci one to eight, paraphyses none; spores definite, ovate.

Perisporium. Perithecium superficial, at length bursting irregularly. Asci club-shaped, not mixed with paraphyses. Spores numerous, ovate.

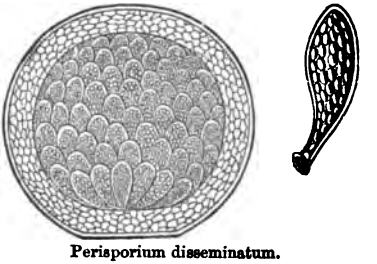
Chætomium. Perithecium superficial, finally open at the mouth, clothed externally with opaque hairs. Asci clavate, mixed with paraphyses. Spores simple, ovate.

Ascotricha. Perithecium thin, at length bursting, clothed with dark, subpellucid, even, obscurely-jointed hairs. Spores simple, contained in linear asci. Superficial, at length free or resting on the investing thallus, black.

Orbicula, Cooke. Perithecium seated on a distinct mycelium, reticulated. Ostiolum obsolete; sporidia subglobose; paraphyses simple or branched.

PERISPO'RIUM, Fr.—A genus of Perisporiacei (Ascomycetous Fungi), consisting of minute, globular, free, punctiform sacs, with fleshy or waxy walls, seated on an obscure thallus, growing on leaves or stalks; finally bursting and collapsing. The spores are produced in large numbers in swollen clavate asci (figs. 558, 559), which are unaccompanied by paraphyses.

Fig. 558. Fig. 559.



Perisporium disseminatum.

Fig. 558. A perithecium in vertical section. Magnified 100 diameters.

Fig. 559. An ascus detached. Magnified 300 diams.

Bibl. Fries, *Sum. Veg.* 404; *Syst. Myc.* iii. 248; Berk. *Ann. N. H.* vi. 432.

PERISTEPHA'NIA, Ehr.—A genus of Diatomaceæ, closely allied to *Stephanodiscus*, differing, however, in having a parallel (and non-radiate) arrangement of the granules; and also to *Systephania*, which differs only in having intramarginal teeth. *P. eutycha* in deep Atlantic soundings; *P. lineata* in guano.

Bibl. Pritchard, *Infus.* 824.

PERITHE'CIUM.—The name applied to the special envelope, mostly of different structure from the rest of the thallus or the receptacle, enclosing the nucleus of the Angiocarpous Lichens and the Pyrenomycetous Fungi.

PERITH'YRA, Ehr.—A doubtful genus of Diatomaceæ. Probably closely allied to *Coscinodiscus*. 2 species from the Ganges.

Bibl. Pritchard, *Infus.* 842.

PERITRO'MUS, St.—A doubtful genus of Infusoria. (Kent, *Inf.* 759.)

PERIZO'NIUM, Cohn et Jan.—A genus of Diatomaceæ.

Char. Frustules navicular, free, encircled with thick linear zones.

P. Braunii (Pl. 51. fig. 42), freshwater.

Bibl. Rabenh. *Alg.* i. 228.

PERO'NIUM, Cohn.—A genus of Monadina allied to *Anthophysa*. It is parasitic on the spores of *Filularia*, and consists of a delicate, colourless fibre surmounted by a globular head which resolves into numerous narrow cells of a monadiform character.

Bibl. Cohn, *Entwick.* 158; Pritchard, *Inf.* 501.

PERONOS'PORA, Ung. See Botrytis, & Smith, *M. M. Jn.* xvi. 120.

PEROPH'ORA, Wiegm.—A genus of Tunicate Mollusca, family Clavelinidæ.

Char. Individuals stalked, roundish, compressed; thorax not marked with granular lines.

P. Listeri. Occurs attached to sea-weeds. Very transparent, appearing like little specks of jelly dotted with orange and brown.

Bibl.. Forbes and Hanley, *Br. Moll.* i. 28.

PERTUSA'RIA, DC.—A genus of Lichenaceous Lichens, having an adnate, uniform thallus, spreading over bark, rocks, &c., and bearing wart-like apothecia, finally exhibiting a depressed pore in their centre, leading to the one or several cells containing the thecæ. *P. communis* is very common on trees.

Bibl. Hook. *Br. Fl.* ii. pt. 1. 164; *Engl. Bot.* pl. 677; Leighton, *Lich. Flora*, 226.

PESTALOZ'ZIA, De Not.—A genus of Melanconiei (Stylosporous Fungi), with septate spores seated on a long pedicel, and crested at the apex (fig. 711). Three species occur in this country. *P. Guepini* is sometimes very destructive to Camellias. They are beautiful microscopic objects.

See fig. under Stylospores.

Bibl. Berk. *Outl.* 324; Cooke, *Handb.* 471.

PETALOM'ONAS, St.—A genus of Flagellate Infusoria. Free, ovate, depressed, flagellum single, long, mouth at the base of the flagellum.

P. abscissa = *Cyclidium abs.*, Duj.; other species; freshwater. (Stein, *Inf.* iii.; Kent, *Inf.* 371.)

PETALONE'MA, Berk. (*Arthrosiphon*, Kütz.).—A genus of Oscillatoriaceæ (Confervoid Algæ), with a remarkable mode of growth. The filaments are branched and cylindrical, with an evident terete, gelatinous, duplicate sheath (Pl. 8. fig. 21). The inner is thin and follows the filament; the outer presents oblique striæ indicating the interposition of lengths of the outer sheaths one inside another, like a series of nested funnels or conical cups. This appearance is produced by the bursting and expansion of each length of the sheath at the apex alone, to make room for the growth of the new cells of the filaments formed at the apex. This structure is analogous to that occurring in Urococcus, where each parent-cell membrane bursts at one side only to allow the new one to emerge, thus at length forming a jointed pedicel. The edges of the funnels of *Petalonema* sometimes become decomposed into curled filamentous processes.

The filaments of *P. alatum* are green and striated, about 1-3000″ in diameter; the inner sheath is yellowish, the outer colourless and 1-400″ in diameter. It forms a brownish stratum on rocks and stones.

Bibl. Berkeley, *Gleanings*, 23, pl. 7; Greville, *Crypt. Fl.* pl. 222; Hassall, *Fr. Alg.* 237, pl. 68; Kütz. *Spec. Alg.* 311; *Tab. Phyc.* ii. 28; Al. Braun, *Rejuven., Ray Soc.* 1853, 178; Rabenh. *Alg.* ii. 265.

PETALOPHYL'LUM, Wilson.—A genus of Pelliæ (frondose Hepaticæ). *P. Ralfsii* is an elegant little Liverwort with the frond plaited or lamellated in rays from the origin of the fruit.

Bibl. *Engl. Bot. Supp.* pl. 2874.

PETAL'OPUS, Clap. et Lach.—A genus of Amœbæa (Rhizopoda). Pseudopodia filiform, arising from one point of the sur-

face, but expanding at the end into a delicate film. The film and pseudopodia become globular before retraction.

P. diffluens (Pl. 52. fig. 16), freshwater.

Bibl. Claparède et Lachmann, *Etudes*, 442.

PETALOT'RICHA, K.—A genus of marine Peritrichous Infusoria. Free, attached to the base of a horny carapace by a peduncle; anteriorly a ring of ciliated petaloid segments. 2 species. (Kent, *Inf.* 627.)

PETALS.—The petals of Flowering Plants afford many interesting microscopic objects, in the epidermis, glandular and other hairs, the colour-cells, and the veins composed of spiral vessels. Entire petals of small size and delicate character form good objects when dried and mounted in Canada balsam. Those of the smaller Caryophyllaceæ, the ligulate corollas of Compositæ, &c., are well suited for this. The larger kinds are studied by means of sections, like Leaves.

PETROBIA, Murr., = *Tetranychus cristatus*.

PETRO'BIUS, Leach.—A genus of Insects, of the order Thysanura, and family Lepismensæ.

P. maritimus has a general resemblance to *Lepisma saccharina*; but it exercises a leaping movement. The antennæ are longer than the body; of the setæ at the tail, the middle one is longest. The insect is of a blackish-brown colour, and is covered with scales; the legs are yellowish, and the caudal setæ ringed with white; the abdomen is furnished will gill-like processes.

It is found upon the rocky sea-coast.

The scales have been used as test-objects.

Bibl. Gervais, *Walckenaer's Apt.* iii. 447; Guérin, *Iconogr. Ins.* pl. 2. fig. 1 *f*; and *Ann. Sc. Nat.* 2 sér. v. 374.

PETRONE'MA, Thwaites.—A genus of Oscillatoriaceæ (Confervoid Algæ). *P. fruticulosa* grows as a frustulose olive-brown crust on limestone rocks (not marine), forming little hemispherical masses; the sheaths are thick and cartilaginous, brown above but colourless at the tips, the protoplasm dull green.

Bibl. *Engl. Bot. Supp.* pl. 2959.

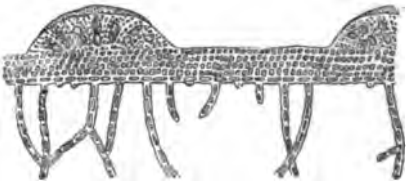
PEYER'S GLANDS. See Intestines (p. 440).

PEYSSONELIA, Dcne.—A genus of Cryptonemiaceæ (Florideous Algæ), consisting of small plants with a depressed lobed thallus (fig. 560), growing overstones, shells, &c., attached by the whole under surface, which produces jointed radical hairs (fig. 561), especially at the thin margins.

Fig. 560.

Thallus. Nat. size.

Fig. 561.



Peyssonelia squamosa.
Vertical section of a portion through two warts.
Magnified 25 diameters.

The thallus is composed of several rows of compact parenchymatous cells, and bears on the concentrically-marked surface warts composed of radiating rows of cells, among which occur crucially-divided *tetraspores*. *P. Dubyi* is not uncommon on British shores; it is 1 to 2″ in diameter, roundish at first, ultimately irregularly lobed, and dull brownish. Thuret has observed *antheridia* on distinct plants of *P. squamosa*, a Mediterranean form; they are jointed filaments collected into wart-like bodies, like those containing the tetraspores.

Bibl. Harvey, *Mar. Alg.* 144, pl. 14 D; *Phyc. Brit.* pl. 71; Thuret, *Ann. Sc. Nat.* 4 sér. iii. 23, pl. 4.

PEZI'ZA, Dill.—A genus of Helvellacei (Ascomycetous Fungi), containing numerous species, a large number of which grow upon dead wood, on the ground, among leaves &c., many brightly coloured. They are at first closed sacs, which burst at the summit, and spread out to form a kind of cup containing asci and paraphyses. Thus they belong to the Discomycetes of some authors.

Tulasne has shown that some of the *Peziæ* have a secondary fructification con-

sisting of *stylospores*; these have been described as species of *Dacrymyces*. Other species also produce *spermatia*; but this was

Fig. 562. Fig. 563. Fig. 564.

Peziza furfuracea. Small variety. Magnified 5 diameters.

long since suspected by Fries. (See Pl. 27. fig. 18.)

Bibl. Berk. *Br. Fl.* ii. pt. 2. 186; Fries, *Summa Veg.* 348; Tulasne, *Ann. Sc. Nat.* 3 sér. xx. 167; Currey, *Jn. Mic. Sc.* v. 124.

PHACELOM'ONAS, Ehr.—A doubtful genus of Infusoria.

Char. Tail-like process absent; a red (eye-) spot present; mouth terminal, truncate, furnished with eight to ten anterior long cilia or flagelliform filaments, vacuoles numerous.

P. pulvisculus. Body oblong, subconical, attenuate posteriorly, bright green; aquatic; length 1-1150″. Occurs in myriads in pools. Perhaps zoospores of Œdogonium.

Bibl. Ehr. *Inf.* 28; Pritch. *Inf.* 494.

PHACIDIA'CEI.—A family of small Ascomycetous Fungi, mostly growing in large numbers on the half-decayed woody parts of plants, or on the ground; consisting usually of dark-coloured indurated or leathery bodies, solitary or connate, or seated on a common base, closed at first and containing a soft nucleus; the outer case (*perithecium*) subsequently opening widely, and presenting a cavity lined with asci containing spores.

The history of development of these plants is still obscure; for many of them are connected with certain of the Coniomycetes as different stages of one and the same plant. We describe the genera according to the existing classifications, noting the new facts relating to these metamorphic phenomena in the articles on the particular genera.

British Genera.

* *Perithecium open, marginal, closed by a lid or veil.*

Patellaria. Perithecium patelliform, margined, open, covered with a thin veil confluent with the nucleus. Disk at length pulverulent, the annulate asci breaking out.

Tympanis. Perithecium cup-shaped, margined, open, covered by a thin, evanescent veil. Disk fixed in the receptacle (*proper stratum*), at length dissolved. Asci filiform, fixed.

** *Perithecium (excipulum) at length open, connate with the floccose receptacle. Nucleus discoid, ascigerous, placed on the receptacle.*

Cenangium. Perithecium entire, leathery-horny, opening by a connivent mouth, distinct from the discigerous stratum. Asci filiform, persistent, expelling the separate spores with violence.

*** *Perithecium entire, dehiscing by closely connivent slits.*

Lophium. Perithecium subsessile, elongated, compressed, bursting by a longitudinal slit. Asci erect, fixed, cylindrical, persistent; sporidia simple, rounded. Thallus crustaceous or imperceptible.

**** *Perithecium somewhat dimidiate, at length open, nucleus naked.*

Rhytisma. Perithecium innate, of irregular form, opening by fragments breaking off into a flexuous slit; nucleus placentiform, persistent. Asci erect, fixed; paraphyses stalked.

Phacidium. Perithecium roundish, simple, bursting with several teeth at the summit; nucleus disk-shaped, in some degree persistent. Asci erect, fixed; paraphyses stalked.

Hysterium. Perithecium sessile, oval or elongated, with a longitudinal slit at first closed, afterwards gaping open; nucleus linear, somewhat persistent. Asci erect, fixed; paraphyses stalked.

Labrella. Perithecium innate, bursting by a longitudinal slit; asci short, broad and obtuse above, attenuated below, mixed with short flexuose paraphyses; spores few, ovate-oblong, occasionally contracted or septate in the middle.

PHACID'IUM, Fr.—A genus of Phacidiacei (Ascomycetous Fungi), containing many species growing on dead leaves, branches, &c. Some of them are common, as *P. dentatum*, on oak-leaves.

Bibl. Berk. *Br. Fl.* ii. pt. 2. 291.

PHACOP'SIS, Tul.—A genus of Microlichens, parasitic on the thallus of *Everniæ* and *Lecanoræ*.

BIBL. Lindsay, *Brit. Lich.* 318; *Qu. Mic. Jn.* 1869, 143.

PHACO'TUS, Perty.—A genus of Cryptomonadina.

Char. Body round, biconvex, with two or four filaments. Probably it is one of the Algæ.

BIBL. Pritchard, *Infus.* 513.

PHA'CUS, Nitzsch, Duj.—A genus of Flagellate Infusoria, family Thecamonadina.

Char. Body flattened and leaf-like, usually green, with an anterior red (eye-) spot, a single flagelliform filament, and covered with a resisting membranous integument, prolonged posteriorly like a tail. Freshwater.

Dujardin distinguishes this genus from *Euglena*, by the constancy of the form of the body, which varies every moment in the latter genus.

P. pleuronectes (Pl. 31. fig. 62). Body oval, almost circular, green, with slightly marked longitudinal furrows, and a tail-like prolongation a third or fourth of its length; length 1-630".

P. longicaudus (Pl. 31. figs. 3 & 63). Other species.

BIBL. Duj. *Inf.* 334; Archer, *Qu. Mic. Jn.* 1871, 99;

PHÆOSPO'REÆ, Thuret. See FUCOIDEÆ, p. 338.

PHALANSTE'RIUM, Cienk.—A genus of Choano-Flagellate Infusoria. Bodies ovate, flagellum single, with a basal collar; imbedded in a simple or branched gelatinous zoary. Two species; freshwater. (Cienkowski, *Arch. mikr. An.* iv. 428; Kent, *Inf.* 361.)

PHALLOIDE'I.—A family of Gasteromycetous Fungi, characterized by the protrusion of a large clavate, columnar, stellate body, or globular, hollow, latticed framework, from the summit of the burst peridium. The basidiospores must be observed early here, as they fall off and form a deliquescent mass upon the hymenium when the sporange is mature. The fleshy structure protruded from the dehiscent capsule is composed of spherical cells very loosely connected; the peridium, which is very tough, is composed of closely packed, very slender, filamentous cells.

BIBL. Berkeley, *Ann. N. H.* iv. 155; *Br. Fl.* ii. pt. 2. 226; Rossmann, *Bot. Zeit.* xi. 185.

PHARCIDIA, Körb.—A genus of Micro-lichens found on the apothecia of *Lecanora*. Spores 8; 2–4-locular, colourless, linear, or rod-shaped. (Lindsay, *Qu. Mic. Jn.* 1869, 343.)

PHASCA'CEÆ.—A family of inoperculate Acrocarpous (terminal-fruited) Mosses, minute, gregarious or cæspitose, with a simple or branched stem. Leaves oblong, oval, lanceolate or spathulate, concave, with a thick cylindrical nerve; the cells of the leaves parenchymatous, looser at the base, by degrees denser towards the summit, mostly papillose. Capsules mostly obliquely apiculate, with spores larger than in most Mosses, but not so large as in ARCHIDIUM. Columella soon vanishing in the smaller species.

British Genera.

Acaulon. Plants very dwarf, gregarious. Capsule contained in the closed perichæte. Calyptra mitre-shaped, dimidiate. Inflorescence monœcious (antheridia on a distinct branch at the base of the stem); or dicœcious (antheridia terminal on a distinct plant), bud-like.

Phascum. Plants cæspitose. Perichæte open. Capsule on a longish stalk, and mostly obliquely apiculate. Calyptra dimidiate. Inflorescence monœcious (antheridia terminal in a bud on a distinct lateral branch, or naked and axillary on the fruit-bearing branch), or dicœcious.

PHASCO'LON, Stein.—A genus of Hypotrichous Infusoria. Free, plano-convex, broadest in front; pharynx enclosing a rod-fascicle. *P. vorticella*; freshwater; length 1-288". (Kent, *Inf.* 746.)

PHAS'CUM, L.—A genus of Phascaceæ (Acrocarpous Mosses), which is now subdivided variously by different authors. Wilson separates the earlier *Ph. alternifolium* only, under the name of *Archidium*; foreign authors further distinguish between PHASCUM, ACAULON, EPHEMERUM, and ASTOMUM. Species retained: *Ph. crispum, cuspidatum, curvicollum, rectum, bryoides. Ph. cuspidatum* is very common on banks, especially on a gravelly soil.

BIBL. Wilson, *Bryol. Br.* 32; Hooker, *Br. Fl.* ii. pt. 1. 6.

PHIALI'NA, Bory, Ehr.—A genus of Holotrichous Infusoria, family Trachelina.

Char. Body finely ciliated, having a kind of neck crowned with large cilia; mouth lateral, below the appendix to the neck; freshwater.

P. viridis (Pl. 31. fig. 61). Body oval, flask-shaped, green, suddenly narrowed in

front and gradually behind, neck short length 1-290″.

P. vermicularis. White.

Bibl. Ehr. *Inf.* 333; Clap. et Lach. *Inf.* 304; Kent, *Inf.* 519.

PHIALONE'MA, Stein.—A genus of Flagellate Infusoria. Free, flask-shaped, oral aperture everted, with a single lateral flagellum. *P. cyclostomum*, surface spirally ribbed or striate; freshwater; length 1-500″. (Kent, *Inf.* 373.)

PHILODI'NA, Ehr.—A genus of Rotatoria, of the family Philodinæa.

Char. Eyes two, cervical; tail-like foot with horn-like lateral processes.

Ehrenberg describes seven species; freshwater; in general structure and appearance closely resembling *Rotifer*.

P. erythrophthalma (Pl. 44. fig. 17). Colourless, smooth, eyes round, processes of foot short; length 1-120 to 1-50″.

P. roseola is reddish, the eyes oval; *P. collaris* has a projecting cervical ring; *P. citrina* has the middle of the body yellowish; *P. macrostyla* has oblong eyes, and the foot-processes very long; in *P. megalotrocha* the eyes are oval, and the rotatory organs very large; and in *P. aculeata* the body is covered with soft setaceous processes.

Bibl. Ehr. *Inf.* 498; Pritchard, *Inf.* 705.

PHILODINÆ'A, Ehr.—A family of Rotatoria.

Char. No sheath or carapace; rotatory organs two, simple, resembling two wheels when the cilia are in motion.

Body usually cylindrical, or somewhat spindle-shaped, contractile even so as to form a ball. In certain states of extension it sometimes appears pointed in front, from the presence of a proboscis; in others the two ciliated rotatory organs are protruded.

The animals are capable of swimming by means of the cilia, or of creeping like a leech, the ends of the body being alternately fixed. The tail-like foot is often furnished with horn-like lateral processes and terminal toes.

Ehrenberg distinguishes seven genera :—

A. Eyes absent.	
α. Proboscis and horn-like lateral process on the foot present	*Callidina.*
β. Proboscis and horn-like processes absent	
a. Rotary organ stalked	*Hydrias.*
b. Rotary organ not stalked	*Typhlina.*
B. Eyes present.	
Eyes two, frontal.	
Foot with horn-like processes.	
Toes two	*Rotifer.*
Toes three	*Actinurus.*
Foot without horn-like processes, but with two toes	*Monolabis.*
Eyes two, cervical	*Philodina.*

Bibl. Ehrenberg, *Infus.* p. 481.

PHILOME'DES, Lilljeborg.—A Cypridinad, with suboval valves, notched in front, spined behind, punctate. Upper antennæ 6-jointed, longer in the male: natatory branch of lower antennæ 9-jointed, secondary branch setose in the female, cheliform in the male. Eyes small and pale in female, large and red in male. 1 British species, rare.

Bibl. Brady, *Linn. Tr.* xxvi. 377; *Pr. Zool. Soc.* 1871, 291.

PHILOPTE'RUS, Nitzsch.—A genus of Anoplurous Insects, of the family Philopteridæ.

Char. Antennæ filiform, five-jointed: maxillary palpi none; mouth with strong toothed mandibles; tarsi with two claws.

The species are very numerous, and have been arranged in six subgenera: *Docophorus, Nirmus, Goniocotes, Goniodes, Lipeurus*, and *Ornithobius*. In some of them there are two movable organs (trabeculæ) situated in front of the antennæ.

P. (Docophorus) communis (Pl. 35. fig. 5). Chestnut-coloured, shining, with white hairs; head triangular, elongate, anterior portion much produced; trabeculæ very large, curved; posterior femora much incrassated and toothed below. Length 1-16″.

Parasitic upon the Passeres or Insessores.

Bibl. Denny, *Anoplur. Monogr.* 62.

PHLE'BIA, Fr.—A genus of Hymenomycetous Fungi, intermediate between Hydnei and Auricularini. The hymenium is soft and pinched up into crest-like wrinkles or veins, which do not form distinct pores. Four species are found in this country, of which two at least are very pretty when in perfection.

Bibl. Fr. *Syst. Myc.* i. 426; Grev. t. 280; Hass. ii. t. 44; Berk. *Outl.* 263; Cooke, *Handb.* 305.

PHLOEM.—The liber-portion of the fibro-vascular bundles of stems.

PHLYCTÆ'NA, Desmaz.—A genus of Sphæronemei (Stylosporous Fungi), nearly related to *Septoria*, differing in the absence of a proper perithecium. *P. vagabunda* has been found in Britain.

Bibl. Berk. and Broome, *Ann. N. H.* 2.

xiii. 460; Desmazières, *Ann. Sc. Nat.* 3. viii. 16.

PHLYCTÆ'NIA, Kg.—A genus of Diatomaceæ.

Char. Frustules those of *Navicula*, enclosed in gelatinous globular cells (masses?). Marine.

P. minuta. Cells 1-720 to 1-240″ in diameter; length of frustules 1-1200 to 1-600″.

P. maritima (*Frustulia mar.*, E.).

Bibl. Kützing, *Sp. Alg.* 96; Ehrenberg, *Infus.* 232.

PHLYCTID'IUM, Br.—A genus of Unicellular Algæ, allied to *Chytridium*; consisting of globose or oblong inoperculate cells, the orifice simple or slightly produced, either rooted or not; gonidia with a single long cilium. Several species; in freshwater Algæ, &c. (Rabenhorst, *Fl. Alg.* iii. 278.)

PHLYC'TIS, Wallr.—A genus of Pertusariei (Lichenaceous Lichens). 2 species, on trees, frequent. (Leighton, *Lichen Flora*, 237.)

PHO'MA, Fr.—A genus of Sphæronemei (Stylosporous Fungi). There are numerous British species, forming small black or brown pustules upon dead leaves, twigs, &c. Tulasne regards this genus as formed by pycnidiiferous states of Sphæria. *P. uvicola* produces the disease called Anthracose on the vine.

Bibl. Berk. *Br. Fl.* ii. pt. 2. 285; *Ann. N. H.* vi. 263; 2. v. 368, xiii. 459; Fries, *Summa Veg.* 421; Tulasne, *Ann. Sc. Nat.* 4. v. 115; Cornu, *Grevillea*, vii. 18.

PHO'NOLITE. See Rocks.

PHORMID'IUM, Kütz.—An obscure genus of Oscillatoriaceæ, the filaments sheathed, forming a membranous layer; many species. (Rabenhorst, *Fl. Alg.* ii. 115.)

PHOR'MIUM, Forst.—*P. tenax* is the name of the plant yielding New-Zealand Flax. It is a Monocotyledonous Flowering Plant belonging to the order Liliaceæ.

PHOR'ODON, Pass.—A genus of Aphidæ. Two species; on the hop (*Aphis humuli*), the sloe, and the plum. (Buckton, *Aphides, Ray Soc.*, i. 165.)

PHOSPHORESCENCE and PHOTOGENIC STRUCTURES, see *Micr. Dict.* 3rd edition, 504; *and the Bibl. therein.*

PHOTOG'RAPHY.—Microscopic objects may be photographed by the ordinary methods, especially by the collodion process, by arranging the microscope so as to form the optical part of a camera obscura. The old solar microscopes are examples of the principle of such an arrangement. Microscopic cameras have been constructed in which the lens is replaced by a fitting carrying achromatic object-glasses, with the rod bearing the stage and illuminating apparatus, as in the ordinary stands of compound microscopes. A simpler plan for those who possess a compound instrument and a camera, is to remove the lens of the latter and introduce into its place the eye-end (with the eyepiece removed) of the compound body, placed in a horizontal position; filling up the crevice all round with a piece of black velvet or cloth. Another method (Wenham's) which dispenses with the camera, is to operate in a room darkened by a shutter having an orifice through which the sunlight may be reflected by a mirror placed outside, and received either directly or condensed by a bull's-eye, on the object lying on the stage of the microscope placed horizontally, with the eyepiece removed; a screen placed at a suitable distance from the eye-end of the tube receives the image. In operating with this screen, the object should be focused on a sheet of card, and then, the light being shut off by covering the eye-end of the tube, a prepared paper or collodion plate be substituted exactly in the same place. Means must be used, by a black cloth or similar contrivance, to shut off all side light between the orifice of the shutter and the object-glass. In this last process, it is possible to obtain pictures with different parts of the object not lying in the same plane, by separate focusing, applying pieces of card suitably cut to shut off the image at different parts as required. With very minute objects and high powers, the achromatic condenser is used, as well as the bull's-eye.

It is well known that the correction of the objectives for perfect vision is not the best for photographic purposes. With high powers, as the 1-4″ object-glass and upwards, the difference may be neglected, but with lower powers, an adjustment is required. Shadbolt finds it sufficient to withdraw the object-glass a little by the fine movement, from the object, and gives the following data for Smith and Beck's object-glass: for the 4-10″, withdraw the objective 1-1000″; for the 2-3″, withdraw it 1-200″; for the 1½″, withdraw it 1-150″. Wenham prefers to place a doubly convex lens in the place of the back stop of the object-glass, and advises for the 4-10″ and 2-3″ object-

glasses a lens of 5″ focus; for the 1½″ a lens of 8″ focus.

Microscopic photographs are best obtained with solar light; but artificial light has been used, as that from camphene or gas for low powers, the oxyhydrogen light for high powers, and Maddox has used the magnesium light. A great point is to secure clean preparations, with the object sufficiently flat to allow of being clearly focused all over; this sets a limit to the utility of the process; further, certain objects in which red and yellow, or yellowish-brown colours exist, do not transmit the light, or only imperfectly. It will probably be advantageous to bleach many objects, as, for instance, insects and their parts, by long maceration in turpentine, sections of dark-coloured wood by nitric acid, &c., when they are intended to be photographed.

The purely photographic manipulation cannot be given here, but requires the ordinary skill in photography. Lengthened particulars respecting the application of photography to the microscope are contained in the papers referred to below.

Bibl. Highley, *Qu. Mic. Jn.* i. 178, 305, and ii. 158; Shadbolt, *Qu. Mic. Jn.* ii. 165; Wenham, *Mic. Tr.* 1855, 2. iii. 1; Rood, *Qu. Mic. Jn.* 1862, 261; Hessling and Kollmann, *Atlas. d. thier. Geweb.* 1862; Maddox, *Tr. Mic. Soc.* 1863, 9; *ibid.* 1865, 34; *Jn. Lond. Photo. Soc.* 1864; *Mn. Mic. Jn.* 1869, 27; Woodward, *ibid.* 29, vol. iii. 290; *Qu. Mic. Jn.* 1870, 380; *Brit. Jn. Photo.* 1866; Moitessier, *Photog. Appliquée*, 1866; Reichardt and Sturenburg, 1868, *Mon. mik. Phot.*; Benecke, *Photogr.* 1869; Hermann, *Phot.*; Gayer, *Micro-photogr.*; *M. M. Jn.* xv. 258; Frey, *Das Mik.*; Beale, *How &c.*, and the notices therein.

PHRAGMIC'OMA, Dumort.—A genus of Jungermannieæ (Hepaticæ), containing one British species, *P. Mackaii* (*Jung. Mackaii*, Hook.), occurring rarely on trees and rocks, especially on limestone.

Fig. 565.

Phragmidium bulbosum.

Isolated basidium with four septate spores. Mag. 100 diams.

Bibl. Hook. *Br. Jung.* 53; Ekart, *Syn. Jung.* 59, pl. 9. fig. 72; Endlicher, *Gen. Plant.* Suppl. i. 472–9.

PHRAGMID'IUM, Lk. (*Aregma*, Fr.).—A genus of Uredinei (Coniomycetous Fungi), forming rusts very common on Rosaceous plants. They appear upon living leaves, breaking through from beneath the epidermis, and are chiefly distinguished from Puccinia by the number of septa which are contained in the spores or pseudospores. *P. bulbosum* is common, forming yellow and brown pulverulent spots on bramble-leaves (see Aregma).

Bibl. Berk. (*Aregma*), *Br. Fl.* ii. pt. 2. 358; Grev. *Sc. Crypt. Flor.* pl. 15; Tulasne, *Ann. Sc. Nat.* 4 sér. ii. 180, pl. 9; De Bary, *Brandpilze*, 1853, 49, pl. 4; Fries, *Sum. Veg.* 507; Currey, *Q. J. Micr. Sc.* v. 117.

PHRAGMOTRICHA'CEÆ.—A family of Coniomycetes, distinguished from Melanconiei by their moniliform chains of spores. See Coniomycetes.

PHRAGMOT'RICHUM, Kze.—A genus

Fig. 566. Fig. 568.

Fig. 567.

Phragmotrichum Chailletii.

Fig. 566. Scale of a spruce-fir cone, with pustules. Half nat. size.
Fig. 567. A pustule, magnified 10 diameters.
Fig. 568. Vertical section across a pustule, showing the chains of spores. Magnified 100 diams.

of Phragmotrichaceæ (Stylosporous Fungi). The plants form little tubercles bursting out from beneath the epidermis, and containing filaments arising from a softish fibrous stroma. The filaments (basidia) are interrupted at intervals with cellular spores (fig. 568), which ultimately separate. *P. Chailletii* grows upon the scales of the cones of *Abies excelsa*. Other species grow on the poplar and maple.

Bibl. Fries, *Syst. Myc.* iii. 492; *Sum. Veg.* 474; Berk. *Crypt. Bot.* 327.

PHTHIR'IUS, Leach.—A genus of Anoplura, family Pediculidæ.

Char. Legs of two kinds, anterior pair formed for walking, posterior pairs for climbing; thorax large, not distinctly separated from the abdomen.

P. inguinalis (*Pediculus pubis*). Parasitic upon man. Length 1-10 to 1-20″.

The ova are firmly fastened to the hairs by a glutinous secretion; they are urn-shaped, and furnished with a lid.

Bibl. Denny, *Mon. Anopl.* 8; Leach, *Zool. Misc.* iii. 65; Mégnin, *Paras.* 75.

PHYCOMY'CES, Kze.—A genus of Mucorini (Phycomycetous Fungi), of which one species, *P. nitens*, has been found in Britain growing on the walls of oil-cellars and on grease. It is olive-coloured, distinguished from *Mucor* chiefly by the absence of a columella, the pyriform peridiole, and oblong spores; but the entire plants are much larger and of more solid texture. The fertile filaments of *P. splendens*, the only other known species, are as thick as a horse-hair, and 3 to 4″ high.

It is the finest of all the Mucorini, and was at first considered an Alga, which it strongly resembles on a superficial examination, when dry, from its green shining threads.

Van Tieghem attributes to this a fructification like that of *Syzygites*, with which genus it must ultimately be combined.

Bibl. Fries, *Syst. Myc.* iii. 309; *Sum. Veg.* 488; Berk. *Ann. N. H.* vi. 433; Van Tieghem, *Ann. Sc. Nat.* 1873, xvii. 292.

PHYCOMYCE'TES.—An order of Fungi composed of microscopic plants of very simple organization, the mycelium being a byssoid or flocculent mass, bearing simple vesicular sporanges (*peridiola*), filled with minute spores. The nature of the membranous wall of the peridioles is not yet well ascertained in all the genera, some authors describing it as merely a veil, others as a perfect sac formed by the expansion of the terminal cell of the filament, which is certainly true in *Mucor*. According to our own observations, the spores are formed by free-cell formation in the peridiole, which ultimately bursts to discharge the spores.

But the division Antennariei cannot stand; Antennaria seems to be merely a form of Capnodium; and Pisomyxa and Pleuropyxis are obscure objects of which little is known.

In the Antennariei the peridioles are sessile on radiating flocci, which sometimes send processes which grow up and surround them, or they are attached to the sides of erect filaments; these filaments form whitish or greyish patches, on the leaves of trees and herbs, bearing a close external resemblance to *Erysiphe*.

The Mucorini are moulds growing on decaying organic matter, the mycelium constituting flocks floating in liquids or overgrowing damp substances, while the delicate spore-sacs or peridioles are borne at the apices of erect stalk-like and often extremely branched filaments. The genus *Syzygites* exhibits a remarkable peculiarity. Each spore-sac is formed by means of the conjugation of two branches of the ramified fructification (see Syzygites).

The later researches on the plants of this group seem to indicate that, as in most of the Fungal Orders, much remains to be cleared up concerning the relations of the forms. See on this subject the article Eurotium, which genus, according to De Bary's researches, is associated as merely a second form of fructification, with Aspergillus, upon the same mycelium.

PHYLACTEL'LA, Hincks, = *Lepralia* pt. (Hincks, *Polyz.* 356.)

PHYLLODE'I.—A series of Lichenaceous Lichens.

Char. Thallus foliaceous, depressed, lobed.

Bibl. Leighton, *Brit. Lich. Flora*, p. 2.

PHYLLOGONIA'CEÆ.—A family of Pleurocarpous Mosses, distinguished by the peculiar character of the leaves and their arrangement. The leaves are either inserted horizontally or imbricated vertically, clasping, and are composed of very narrow linear parenchymatous cells, appearing almost confluent into a homogeneous membrane, auricled at the base, with minute, parenchymatous, thickened alar cells arranged orbicularly at the auricles, very smooth; the leaves stand in two opposite rows.

This family contains only the single small exotic genus *Phyllogonium*.

PHYLLOM'ITUS, Stein.—A genus of Flagellate Infusoria. Free, ovate; flagella two, unequal, united at the basal portion; no mouth. *P. undulans*, freshwater. (Kent, *Inf.* 209.)

PHYLLOPH'ORA, Grev.—A genus of Cryptonemiaceæ (Florideous Algæ), consisting of several species, with a red, rigidly membranous, stalked, leaf-like, often dichotomous thallus, the lobes of which are often proliferous; from a few inches to a foot long, growing near low-water mark, or in the sea. (*P. rubens*, Pl. 4. fig. 4.)

The fructification consists of:—1. *favellidia*, scattered over the thallus, containing minute spores; 2. *antheridia*, wart-like bodies composed of radiating moniliform

filaments found on distinct plants from the spores; and 3. *tetraspores*, collected into sori either towards the apex of the thallus or on proper lobes.

BIBL. Harvey, *Mar. Alg.* 142, pl. 18 A; *Phyc. Brit.* pl. 191; Greville, *Alg. Brit.* pl. 15; Derbès and Solier, *Ann. Sc. Nat.* 3 sér. xiv. 277, pl. 37; Thuret, *ibid.* 4 sér. iii. 18.

PHYLLOP'ODA. See ENTOMOSTRACA.

PHYLLOXE'RA, Fonsc.—A genus of Aphidæ (Homopterous Hemiptera); the species have the fore wings flat on the back, with 1 simple stigmal, and 2 simple oblique discoidal nerves; the antennæ 3-jointed.

These insects are notable from the immense damage they do, in the vinicolous countries, to the grape-vines. The apterous broods feed upon the roots of the vine, exhausting its juices, producing decay of the leaves, and absence of fruit. In the autumn, the winged sexual forms are produced, which spread the malady abroad, by laying their eggs in new places. *P. vastatrix* (Pl. 53. fig. 7) is the vine-pest; but other species occur on the oak, &c. The insects may be found by separating the layers of the roots, and examining them with a good lens, when they will be seen in all stages, often surrounded with a zone of eggs.

BIBL. Westwood, *Intr.* ii.; Fatio and Demole-Ador, *Rap. s. l. Phyll.* 1875–76; Lichtenstein, *Ann. Agronom.* 1876, ii. 129; Robin, *Micr.* 1877, 953; Balbiani, *Rev. Scient.* 1874; Cornu, *Phyll. vast.*, 1878 (24 plates).

PHYMATOP'SIS, Tul.—A genus of Microlichens parasitic on the apothecia and thallus of Usneæ.

BIBL. Lindsay, *New-Zealand Lich. and Fungi*, 442; *Qu. Mic. Jn.* 1869, 350.

PHYSAC'TIS, Kütz.—A genus of Oscillatoriaceæ (Confervoid Algæ), improperly separated from *Rivularia*, consisting of freshwater and marine plants, growing on stones &c., at first globose, and afterwards vesicular and lobed by peripheral growth accompanied by gradual decay of the originally solid centre. Under this head are included:—

P. (*Rivularia*) *nitida*. Deep olive-green, tufted and lobed, gregarious; fronds from 1-12 to 1″ in diameter. (*R. bullata*, Berk.) Marine.

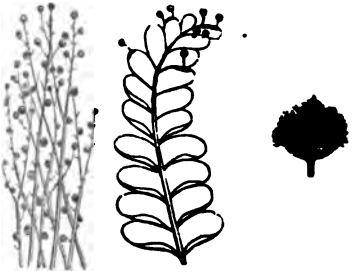
P. (*Riv.*) *plicata*. Diam. 1-12 to 1-2″ in diameter; deep green. Marine.

P. (*Riv.*) *pisum*. Globose, dirty green, 1-12 to 1-2″ in diameter. Freshwater.

BIBL. Kütz. *Sp. Alg.* 332; *Tab. Phyc.* Bd. i. pl. 58; Hassall, *Fr. Alg.* 262; Harvey, *Mar. Alg.* 222; Berk. *Gleanings*, pl. 2. fig. 1; Rabenh. *Alg.* ii. 206.

PHYSA'RUM, Pers.—A genus of Myxomycetes, containing numerous species growing on rotten wood, bark, leaves, &c. They are nearly related to *Didymium* and *Diderma*, but have a simple membranous peridium: the filaments are adnate to the peridium; but in some spores they are very few, approaching to the condition of *Licea*. Some are sessile, others stipitate (fig. 569); the clustered forms (*P. hyalinum* and *utriculatum*) are removed to Berkeley's genus BADHAMIA. *P. album* is common.

Fig. 571. Fig. 569. Fig. 570.



Physarum bryophilum.

Fig. 569. Plants growing on a Plagiochila. Magn. 2 diams.
Fig. 570. A peridium burst. Magn. 25 diams.
Fig. 571. Filaments and spores from the same. Magn. 100 diams.

BIBL. Berk. *Br. Fl.* ii. pt. 2. 314; *Mag. Zool. and Bot.* i. 49; *Ann. N. H.* vi. 431, 2. xiii. 159; Fries, *System. Myc.* iii. 127; *Sum. Veg.* 153; Greville, *Crypt. Fl.* pl. 40. 310; Cooke, *Grevillea*, 1880; Kent, *Pop. Sc. Rev.* 1881, and *Inf.* 470.

PHYS'CIA, Nyl.—Like *Parmelia*, but with the spores bilocular; many species.

PHYSCOMIT'RIUM, Bridel.—A genus of Funariaceæ (Acrocarpous Mosses), including many *Gymnostoma* of other authors. *Physcomitrium pyriforme*, Brid. = *Gymnostomum pyriforme*, Hedw. *Ph. sphæricum* is remarkable as having been found only in one year in one locality in Britain.

This species exhibits a pretty structure in a vertical section of the immature capsule, the mass of sporiferous tissue being suspended freely in the middle by cellular threads.

PHYSIOTIUM, Nees.—A genus of Jungermanniæ (Hepaticæ), containing one

species, *P. cochleariforme*, a large plant, growing in purple tufts 4 to 6″ long, on moors and among rocks in Ireland and the Scotch highlands.

BIBL. Hook. *Brit. Flor.* ii. pt. 1. p. 119; *Br. Jung.* p. 68; *Engl. Bot.* pl. 2500; Ekart, *Synops. Jung.* pl. 5. fig. 40; Endlicher, *Gen. Plant.* Suppl. 1. nos. 472–81.

PHYSODIC'TYON, Ktz.—A genus of Algæ, consisting of globular vesicles composed of angular parenchymatous cells containing chlorophyll; diameter 1-12″. On rocks and submerged wood. *P. graniforme* (Pl. 3, fig. 14). (Rabenhorst, *Alg.* iii. 312.)

PHYSOM'ONAS, Kt.—A genus of Flagellate Infusoria. Rounded, free or fixed by a slender filament; obliquely truncate in front; flagella two, unequal; diam. 1-3000″; freshwater and marine. (Kent, *Inf.* 263.)

PHYTEL'EPHAS, R. and P.—The generic name of the Palm yielding the VEGETABLE-IVORY nut.

PHYTOCRE'NE, Wallich.—An Artocarpaceous tree with wood of very remarkable structure. See WOOD.

PHYTOPTIDÆ.—A family of Acarina, the nature of which is ill-understood. The members are found in the buds and galls of plants. The galls, which form warts, tubercles, nail-like growths &c. upon the leaves, and produce distortion of the buds, were formerly considered fungi, and placed in the genera *Erineum*, *Phillerium*, &c. The Acari are usually elongate, the body transversely striated, the legs two anterior pairs, the hinder pairs being replaced by tubercles or long hairs. They were supposed to be the larvæ of *Tetranychus* or other Acarina, but their eggs are found with them in the galls. They have not been properly arranged in genera and species, being usually referred to the single genus *Phytoptus*, Duj. They are often very transparent and easily overlooked, and sometimes can only be found by washing the opened galls, and searching for them in the wash-water. They are commonly met with in the galls of the lime, the vine, the willow, the pear, yew, &c., and are named accordingly *P. tiliæ* (Pl. 53. fig. 24), *P. vitis*, &c.

BIBL. Dujardin, *Ann. Sc. Nat.* 1857, iii. 15; Pagenstecher, *Verh. Heidelb.* 1859; Frauenfeld, *Verh. zool.-bot. Ges. Wien*, 1864–72; Löw, *ib.* 1874; Thomas, *Zeitschr. gesammt. Naturw.* xxxiii.; Kaltenbach, *Pflanzfeinde*; Briosi, *M. M. Jn.* xvii. 181 (with copious Bibl.); Ormerod, *Inj. Ins.* 179; Murray, *Ec. Ent.* 365.

PICO'BIA, Hall.—A genus of Trombidina (Acarina). *P. Heeri*, in the subcutaneous cellular tissue of the woodpecker.

BIBL. Mégnin, *Paras.* 248; Haller, *Zeitschr. wiss. Zool.* 1877, xxx.

PIGGO'TIA, Berk. and Broome.—A genus of Sphæronemei (Stylosporous Fungi), or perhaps the conidiiferous form of *Dothidea*. *P. astroidea* occurs on the green leaves of the elm, forming irregular roundish, granulated or wrinkled jet-black patches (sometimes with a yellow border) on the upper surface of the leaf. Perithecia soon confluent, bursting by a lacerated fissure.

BIBL. Berk. and Broome, *Ann. N. H.* 2. vii. 95, pl. 5. fig. 1.

PIGMENT. See INTRODUCTION, p. xxxiv.

PIGMENT-CELLS of connective tissue occur in a few isolated spots only in Man and the higher Vertebrata, but are widely distributed in Amphibia and Fishes, appearing especially in the skin, the serous membranes, and the tunica adventitia of the vessels. The pigment is deposited in granules, which differ in shape and colour. The pigment-cells of connective tissue are usually characterized by their beautiful stellate form and numerous processes. In Man they occur normally in the eye. The pigment-granules in Amphibia are collected in round masses or diffused in the stellate cells, their movement being evident but slow. Spontaneous alteration in form of pigment-cells occurs in the skin of these animals, and is connected with the change in colour which they present. See MELANINE.

PILA'CRE, Fr.—A genus of Trichogastres (Gasteromycetous Fungi).

This genus must not be confounded with *Onygena*, to which it bears a certain resemblance. One or two of the species are remarkable for the strong permanent odour, resembling that of pigs.

BIBL. Berk. and Broome, *Ann. N. H.* 2. v. 365, pl. 11.

PILEOLA'RIA, Cast. See UROMYCES.

PILEORHI'ZA.—A conical hood on, or shield or guard to, the tips of the roots of plants, protecting the nascent tissue. See ROOT.

PILIN'IA, Kütz.—A genus of Chætophoraceous Algæ. Filaments erect, jointed, tufted, rooting, forming a spongy stratum. *P. rimosa* (Pl. 3, fig. 15), on submersed wood; marine. (Rabenhorst, *Alg.* iii. 386.)

PILOBO'LUS, Tode.—A genus of Mucorini (Phycomycetous Fungi), consisting of little moulds growing upon dung; bear-

ing some resemblance in their structure to *Botrydium* among the Algæ. The plants have a stoloniferous creeping mycelium, from which arise fertile pedicels, each cut off from the mycelium by a septum; the upper part of the pedicel expands into the vesicle, which also becomes shut off by a septum; in the vesicle or peridiole, spores are next developed by free-cell formation, and at the same time the septum becomes pushed up into its interior (as in MUCOR) to form a columella, which ultimately causes the vesicular peridiole to split off by a circumscissile dehiscence just above the septum; it is thrown off with elasticity, enclosing the spores. The development of *P. crystallinus* has been studied by Cohn and Bail. They find the germinating spore to produce a creeping unicellular mycelial portion, and next a fruit-pedicel, which soon has the peridiole separated by a septum; thus, in its simplest form, this plant consists of only three cells; subsequently it becomes complex by the root-cell or mycelium producing numerous stolons. *P. crystallinus* is yellowish at first, the peridiole finally black. *P. roridus*, Bolt., a doubtful species, is smaller and more slender than the last, having an elongated filiform stem.

BIBL. Berk. *Br. Fl.* ii. pt. 2. 231; Fries, *Sum. Veget.* 487; Cohn, *Nova Acta*, xxiii. 492; Bail, *Bot. Zeit.* xiii. 630; Currey, *J. Linn. Soc.* Botany, i. 162.

PILOPH'ORON, Tuck.—A genus of Cladoniei (Lichenaceous Lichens). *P. fibula*, on wet rocks, rare. (Leighton, *Lich. Fl.* 69.)

PILOT'RICHUM, Pal. de Beauv.—A genus of Hypnoid Mosses, including some *Fontinales* of authors.

Pilotrichum antipyreticum, C. Müll. = *Fontinalis antipyretica*, L.

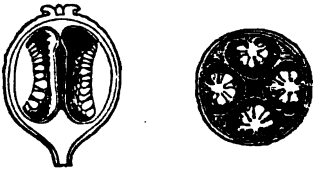
P. squamosum, C. Müll. = *F. squamosa*, L.

P. ciliatum, C. Müll. = *Ancectangium ciliatum*, Brid., var. γ. *striatum* = *A. ciliatum*, Wilson.

P. heteromallum, P. d. B. = *Daltonia heteromalla*, H. and T.

PILULA'RIA, L.—A genus of Marsileaceous Plants, containing the only British representative of the order—*P. globulifera* (fig. 574). This is an inconspicuous plant growing in mud at the edges of or in pools, having a filiform creeping stem, bearing erect filiform green leaves and delicate adventitious roots, and producing shortly-stalked globular spore-fruits, about the size of a pepper-corn. The anatomical structure of the stem and leaves is simple: they are clothed with an epidermis possessing stomata; and a cross section both of the stem and the leaves exhibits a central vascular bundle (of spiral vessels) surrounded by a sheath of brownish cells, while in the delicate cellular tissue intervening between the central bundle and the epidermis stands a circle of air-passages separated from each other by simple radiating cellular septa.

Fig. 572. Fig. 573.



Pilularia globulifera.

Fig. 572. A vertical section of a spore-fruit. Magn. 5 diameters.

Fig 573. Transverse section of a spore-fruit. Magn. 5 diameters.

The spore-fruits are hollow cases with an outer tough cellular coat, and an inner more delicate coat dipping in at four perpendicular lines, as far as the centre, so as to form dissepiments dividing the fruit into four chambers (figs. 572, 573); up the centre of the outer wall of each chamber runs a raised ridge, a kind of placenta, whence arise the sporanges or *thecæ* (fig. 573). These are pear-shaped sacs composed of a very delicate cellular membrane. Those in the upper part of each chamber contain a number of minute globular bodies (microspores), resembling pollen-grains, immersed in a gelatinous liquid. The sacs in the lower part of the chamber contain only one body or spore (macrospore) of very peculiar form; it nearly fills the theca, is somewhat oval, and possesses several coats.

In the development of the spores the small spores are developed in the usual way, by the formation of parent cells in the theca, each subsequently producing four spores. In the thecæ which have the single large spore, a number of parent cells are originally produced; and these become divided into four chambers by septa; but then all but one of these decay. This produces four spores; but out of these four, only one attains perfect development, the rest being subsequently dissolved and absorbed to make room for the solitary large spore. The two kinds of spore in *Pilularia*

correspond to the two forms in SELAGINELLA and ISOËTES, and to the pollen and ovules of the Flowering Plants. They are set free by the dehiscence of the spore-fruit, and lie at first imbedded in the jelly poured out by the thecæ.

In this state the small spores resemble pollen-grains, having an outer granular, and an inner delicately membranous coat,—the outer coat presenting ridges corresponding to the points of contact in the parent cell. When set free, the spores soon burst at these ridges, and the inner coat is slightly protruded; this next bursts and discharges a number of lenticular cells, from each of which escapes a ciliated spiral spermatozoid.

The mature large spores (fig. 575) are of oval form, and have a thick outer gelatinous coat composed of prismatic cells standing perpendicularly on an inner glassy coat; the gelatinous coat is perforated at the summit by a funnel-shaped opening through which protrudes a pyramidal elevation of the second, glassy coat; the last is lined by a delicate internal coat containing protoplasm, starch, oil-globules, &c. Soon after the expulsion of the spore, cell-formation takes place inside the pyramidal protrusion of the outer coat, from the cell-contents of the spore. The glassy coat next splits at this point into four teeth, and exposes the cellular structure (*prothallium*), which increases in size, and acquires a green colour. An archegonium is next formed on this, consisting of a cell (embryo-sac) lying in the substance at the apex, with a canal bordered by four papillose cells leading to it. A spermatozoid fertilizes the free embryo-cell contained in the archegonium; and this becomes developed into a new plant within the substance of the prothallium (fig. 577), sending out a leaf on one side and an adventitious root on the other, tangentially to the surface of the spore. In this stage (fig. 578) the young plant, with the remains of the spore, somewhat resembles a germinating Monocotyledonous seed. Finally, as the young plant increases in size, the remnants of the spore-coat are thrown off.

Fig. 574. Fig. 575. Fig. 578.

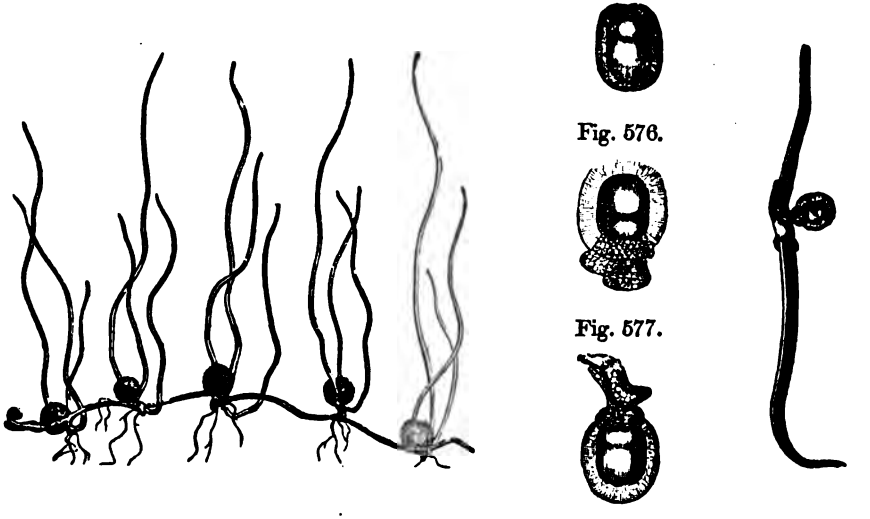


Fig. 576.

Fig. 577.

Pilularia globulifera.

Fig. 574. Natural size.
Fig. 575. An ovule spore. Magnified 25 diameters.
Figs. 576 & 577. The same in germination. Magnified 25 diameters.
Fig. 578. Germinating spore more advanced. Magnified 10 diameters.

BIBL. Valentine, *Linn. Tr.* xvii.; Hofmeister, *Vergl. Unters.* 1851, 103; Henfrey, *Ann. N. H.* 2. ix. 447; Hanstein, *Pilul. &c.*

1866, Braun, *Monatsb. Berl. Ak.* 1870; Sachs, *Bot.* 444.

PINE-APPLE. See BROMELIACEÆ.

PINNULARIA, Ehr.—A genus of Diatomaceæ, family Naviculaceæ.

Char. Frustules single, free, longer than broad; front view linear or oblong; valves navicular, elliptical, lanceolate, or oblong (side view), with a median line, and a nodule at the centre and at each end; surface exhibiting transverse or slightly radiating striæ or furrows (costæ).

This genus differs from *Navicula* in the striæ not being resolvable into dots. They are mostly distinct under ordinary illumination. In some of the species they are absent in the middle, leaving a transverse clear space or band, resembling in appearance the stauros of *Stauroneis*. Many species.

P. nobilis (Pl. 15. fig. 1, side view). Valves linear, dilated in the middle and at the rounded ends; striæ coarse. Freshwater and fossil; length 1-100 to 1-70″.

P. viridis (Pl. 15. fig. 2, side view). Valves elliptical, somewhat turgid, ends obtuse; freshwater; length 1-500 to 1-220″; common.

β. Striæ parallel, absent from a transverse band.

P. oblonga (Pl. 15. fig. 3, side view). Valves linear-oblong, ends rounded; freshwater and fossil; length 1-120″; common.

P. radiosa (Pl. 15. fig. 4, side view; fig. 5, front view). Valves lanceolate, ends somewhat obtuse; freshwater; length 1-500″; common.

BIBL. Smith, *Br. Diat.* i. 54, ii. 95; Ehr. *Abh.* 1840, 20; Donkin, *Mic. Jn.* 1861, 8; Pritchard, *Inf.* 899; Kütz. *Sp. Alg.* 81; Gregory, *Diat. of Clyde*, 7; *Q. Micr. Jn.* ii. 28, 98; Grün, *Wien. Verh.* 1860, 524; Rabenh. *Alg.* iii. 209; Pfitzer and O'Meara, *Qu. Mic. Jn.* 1872, 386.

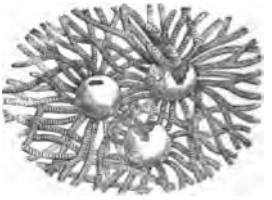
PI'NUS, L.—A genus of Coniferæ (Gymnospermous Flowering Plants), presenting many interesting points of structure. The most familiar example is the Scotch Fir (*P. sylvestris*); but a great number of other species are cultivated in this country. For the microscope they yield instructive objects:—in the wood (Pl. 48. fig. 1), composed of peculiarly pitted cells (see CONIFERÆ) and traversed by turpentine-reservoirs; in the BARK, which has a kind of false cork; in the development of the Gymnospermous OVULES, and in the structure of the POLLEN-grains.

The wood of species of the genus *Pinus* frequently occurs in a fossil condition (Pl. 25. figs. 29–33).

BIBL. See the articles above cited.

PISOMYX'A, Corda (*Bryocladium*, Ktz.).—A genus of Mucorini (Phycomycetous Fungi), growing upon leaves. A species has occurred in Ceylon on the leaves of *Amomum*.

Fig. 579.



Pisomyxa racodioides.
Magnified 200 diameters.

BIBL. Fries, *Sum. Veg.* 406; Corda, *Ic. Fung.* i. pl. 6. fig. 292; Berk. and Broome, *Linn. Jn.* xiv. 139, t. x. f. 54.

PISTIL.—The parts of a flower included in the terms ovary, style, and stigma. It is in theory composed of modified leaves or carpels.

PISTILLA'RIA, Fr.—A genus of Clavariei (Hymenomycetous Fungi), consisting of small club-shaped heads which are confluent with the stem. There are about six species indigenous to this country, of which that on fern-stems is the most common.

BIBL. Fr. *Ep.* 586; Berk. *Outl.* 286; Cooke, *Handb.* 342.

PISTILLID'IUM=ARCHEGONIUM, the female reproductive organ of the higher Cryptogamia.

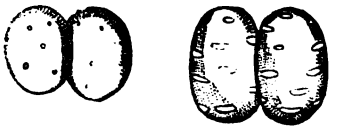
PITH. See MEDULLA.

PITHOPH'ORA, Wittr.—An obscure genus of Algæ. (Wittrock, *Qu. M. Jn.* 1877, xvii. 293; Moore, *Jn. Bot.* 1877; *M. M. Jn.* xviii. 40.)

PITTED STRUCTURES OF PLANTS.—The secondary deposits of cellulose which form the layers of thickening of the walls of vegetable cells are seldom uniform or homogeneous in character. In most, if not in all, cases some special microscopic structure may be distinguished, either by mere inspection or on the application of reagents. These layers, spoken of more particularly as to their nature under SECONDARY DEPOSITS, may be divided into two classes, com-

prehending pretty accurately all the varied conditions, namely:—the *Spiral deposits*, where the secondary layers assume the aspect of fibres applied upon the inside of the cell-wall; and *Pitted*, or, as they are often termed, *Porous deposits*, where layers are applied over the whole internal surface of the cell, which layers present orifices of different characters, leaving the primary membrane bare, and forming in this way a *pit* as viewed from the inside of the cell. When the secondary layers are comparatively thin, their presence is often overlooked; and the pits have thus often been mistaken for orifices or *pores* (figs. 580, 581) in the primary

Fig. 580. Fig. 581.



Pitted cells of Elder pith.
Magnified 250 diameters.

membrane; but such pores are never originally present; the closure of the pit by the layer of primary membrane may always be demonstrated in young structures; and when orifices really do occur in cell-walls, these arise from the absorption of the primary cell-membrane converting the pit into a pore. The best way of demonstrating that young spotted cell-walls are only pitted and not perforated, is to apply sulphuric acid and iodine for the production of the blue colour in the primary cell-wall.

Simple pits, of no great depth, occur on the slightly thickened walls of most permanent parenchymatous cells; they may be seen in the cells of herbaceous stems, in pith, bark, in the cells of the parenchyma of leaves, &c. (Figs. 580, 581; Pl. 47. fig. 14.)

In most prosenchymatous wood-cells, or liber-cells, and in the woody cells of the stones or shells of fruits and seeds, the pits are far more clearly evident, and become more and more distinct (Pl. 48. fig. 3), as the layers of thickening increase in number, since, by the successive application of these, the pits are deepened (with the contraction of the cavity of the cell) until they become canals or tubular passages radiating from the central cavity (Pl. 47. fig. 23). In these cases it is evidently seen that the pits of adjacent cells and ducts correspond to each other at their outer extremity; and in old tissues, when the primary cell-walls have been absorbed, these coincident pits form tubular canals leading from one cell to another. It has been observed that two or more pits sometimes become confluent in the later internal deposits, so that the internally simple orifice leads out to several branches corresponding to the original pits on the wall of the cell. In rare cases, simple pits occur on the outer walls of epidermal cells, as in *Cycas* (Pl. 47. fig. 28).

Pits of the above kinds occur on the structures called ducts (see TISSUES, VEGE-

Fig. 582. Fig. 583.

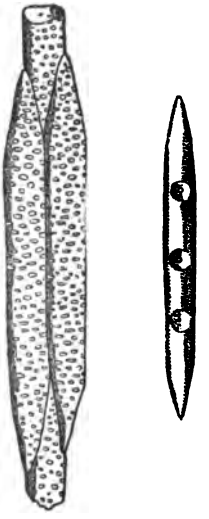


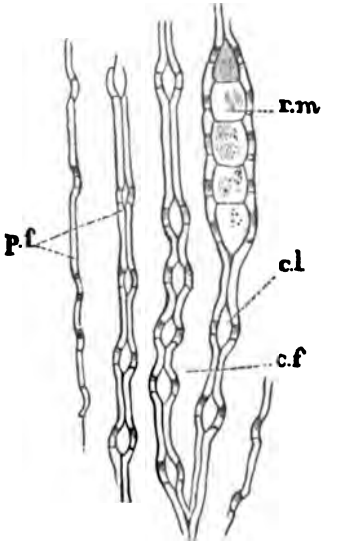
Fig. 582. Pitted ducts of Clematis. Magn. 100 diams.
Fig. 583. Side wall of a cell of Pine, with bordered pits. Magnified 200 diameters.

TABLE), formed of cells applied end to end and confluent (fig. 181, page 271). These large pitted tubes (which occur abundantly in most woods, with the exception of that of the Coniferæ) are sometimes termed *bothrenchyma*, signifying *pitted tissue*; but the character not being exclusively applicable to them, the name is bad.

In many pitted ducts, and in the pitted wood-cells of many plants, especially of the Coniferæ, the pits present a greater degree of complication. The markings on the walls of the wood-cells of most of the Coniferæ, for example, consist of pits surrounded by a

broad rim (fig. 583; Pl. 48. figs. 1, 4, 5); the portion within the rim projects somewhat into the cavity of the cell, and appears like a lenticular body attached on the wall; hence the markings were formerly termed the "glands" of Coniferous wood. In reality, however, while the pits themselves resemble ordinary pits, the broad rim, or rather the circular line outside the pit, depends on a condition of the cell-wall outside the membrane, and is merely the outline of a lenti-

Fig. 584.



Section of Pine wood at right angles to the pitted walls. *p. f*, walls of a pitted cell; *c. f*, cavity of a cell; *c. l*, lenticular cavity between two adjacent pits; *r. m*, cells of a medullary ray, the pits have no rim here.

Magnified 400 diameters.

cular cavity existing between two adjacent cells, the boundary of which is visible through the wall on account of the transparency of the latter: the nature of this structure is very evident in sections made at right angles to those which show the bordered pits in face (fig. 584; Pl. 48. fig. 1 *b*). In most of the Coniferæ the wood is exclusively composed of large elongated prosenchymatous cells, with bordered pits of this character on the side walls (that is, on the walls standing radially or perpendicular to the bark); the pits, however, which lie on parts of the wall adjoining the cells of medullary rays, are generally devoid of the rim.

Similar bordered pits occur very generally on the walls of the pitted ducts of Dicotyledons; but as the wood is here of mixed composition, and the ducts adjoin cells as well as other ducts, independently of the medullary rays, we often find a greater variety of conditions on the wall of the same duct, which may have bordered pits when adjoining another duct, and simple pits, or pits with a double outline, when adjoining cells. The pits with a double outline (Pl. 48. figs. 15 *b*, & 20) are of different nature from the bordered pits (Pl. 48. figs. 13, 14, 15 *a*, 16, 18), the double outline depending simply on the fact that the later or more internal layers of thickening do not reach the edge of the orifice in the earlier secondary deposits, so that the pit is conical, or rather has sloping edges, the circumference at the primary membrane being rather less than that of the margin next the cell-cavity. A peculiar modification of this unequal mode of deposit is seen in company with the true rim or border in many cases (Pl. 48. figs. 14, 16, 18), where the central spot or original pit appears in the middle of a slit running across the circle indicating the border; this slit indicates the alteration of the shape of the gap in the secondary deposits in the successive layers, and corresponds to the inner margin of the pit, where this has the form of an elongated groove or slit, gradually diminishing to a small round hole towards the primary cell-membrane (Pl. 48. fig. 18 *a*). Sometimes (Pl. 48. fig. 18 *a*, *b*) the two or more slits formed in this way on contiguous pits become confluent. The last condition indicates a transition to the more sparing form of the secondary deposit where it appears as a modification of a spiral fibre or fibres; and the later secondary deposits of pitted ducts do sometimes actually assume this form, and produce a spiral-fibrous layer of thickening inside the layers perforated by pits. This is the case in Taxus (Pl. 48. figs. 4), in the Lime (Pl. 48. fig. 13), and Mezereon (Pl. 48. fig. 19 *b*), &c.

Hartig and Mohl have described a peculiar kind of pitted tissue formed of cells, which the former calls *Siebröhren*, or sieve-tubes, the latter *clathrate cells*. They are thin-walled cells occurring associated with the prosenchymatous liber-cells of Dicotyledons, and forming part of the *vasa propria* of Monocotyledons; having their walls marked with large shallow pits, the mem-

brane of the pits being again very finely punctate or reticulated; Hartig regards the fine punctuations as holes.

For the guidance of microscopic observers, we may furnish a series of examples (in addition to those of the CONIFERÆ, Pl. 48. figs. 1, 4, 5), of the different kinds of marking on pitted cells and ducts.

A. *Forms where there is no spiral-fibrous secondary deposit.*

a. Bordered pits uniformly distributed, without reference to adjacent structures; *Elæagnus acuminata, Clematis Vitalba* (Pl. 48. fig. 18).

b. Bordered pits fewer on the walls adjoining cells: *Acacia lophantha, Sophora japonica.*

c. Bordered pits on the walls adjoining ducts, while the walls adjoining wood-cells have few or no bordered pits, and those next the medullary rays have pits without a border: elder, beech, hazel, poplar, alder, plane, apple, &c.

d. Bordered pits on the walls adjoining ducts, but with large pits devoid of a border where adjoining cells: *Cassytha glabella* (Pl. 48. fig. 14), *Bombax pentandrum* (Pl. 48. fig. 15).

e. A modification of the last, where the bordered pits have the form of slits as wide as the ducts when adjoining ducts, while the walls adjoining cells have large pits without a border: *Chilianthus arboreus* (Pl. 48. fig. 17); the vine (in a less striking manner). *Eryngium maritimum* (Pl. 48. fig. 21) exhibits a condition approaching this.

f. Sieve-tubes or clathrate cells, large thin-walled cells with round, oval, or elongated thinner places (pits) on their walls, the membrane of the pit being finely reticulated or perforated like a sieve. These are found in the liber of Dicotyledons, as in *Bignonia*, the lime, the vine, elder, pear, &c., and in the central part of the vascular bundles of Monocotyledons, as *Musa, Asparagus*, &c.

B. *Forms where a spiral-fibrous structure is added after the pits.*

g. All the ducts with bordered pits, but the larger ducts with smooth walls, the smaller with a spiral fibre: *Clematis Vitalba, Ulmus campestris, Morus alba.*

h. All the ducts closely pitted, with slender fibres between the rows of pits: *Hakea oleifolia.*

i. The larger ducts with pits, the smaller without; both kinds with spiral fibres on the internal surface: *Daphne Mezereum* (Pl. 48. fig. 19), *Passerina filiformis, Genista canariensis.*

j. The walls adjacent to other ducts pitted, those next cells with very distant pits, or devoid of them; all the walls with fibres: the lime, horse-chestnut, sycamore, cornel, holly, hawthorn, *Prunus Padus, P. virginiana*, &c.

The last set of forms allies these structures to those characterized peculiarly by the SPIRAL-FIBROUS STRUCTURES; and, as will be indicated there and under SECONDARY DEPOSITS, the smooth layers of thickening, such as those between the pits of *Pinus*, may be made to show a spiral structure by the action of reagents.

For the micro-chemical conditions of these objects, their development and relations, see SECONDARY DEPOSITS; TISSUES, Vegetable; and CELL, Vegetable.

BIBL. Works on Structural Botany, and the *Bibl.* of SPIRAL STRUCTURES.

PLACENTA OF PLANTS.—The region of the carpel whence ovules arise. Stroma would be a preferable term.

PLACO'DIUM.—A genus of Placodei (Lichenaceous Lichens); 13 species, on rocks and walls. (Leighton, *Lich. Fl.* 100.)

PLACOPSIL'INA, D'Orbigny.—*Lituolæ* of irregular growth and attached, belong to this subgenus.

BIBL. Carpenter, *For.* 143.

PLA'CUS, Cohn.—A genus of Holotrichous Infusoria. Free, ovate; surface indurated, reticular, mouth inferior; movement rotatory; length 1-780″; salt water. (Kent, *Inf.* 489.)

PLAGIACAN'THA, Claparède.—A genus of Acanthometrina (Rhizopoda).

Char. The spicula, which are branched and without a central canal, do not unite in the centre of the body, but on one of the sides, so as to form a scaffolding on which the sarcode rests; pseudopodia elongating either at the ends or sides of the spicula to which they are attached, and which they unite more or less together.

BIBL. Clap. et Lach. *Etudes*, 461.

PLAGIOCHI'LA, Nees and Montagne.—A genus of Jungermannieæ (Hepaticæ), containing a number of British species, viz. *P.* (*Jungermannia*, Hook.) *asplenioides, spinulosa, decipiens, resupinata, undulata* (fig. 321), *planifolia, nemorosa*, and *umbrosa*, some of which, especially *P. asplenioides* (fig. 585), are among the most frequent and finest

plants of the family, its stems growing from 3 to 5″ long.

BIBL. Hook. *Br. Fl.* ii. pt. 1, 111; *Br. Jung.* pls. 13, 14; Ekart, *Synops. Jung.* 6 *et seq.* pl. 1; Endlicher, *Gen. Plant.* Supp. 1, No. 473.

PLAGIODIS'CUS, Gr.—A genus of Diatomaceæ. Allied to *Surirella*, but the costæ radiating at the ends. 2 species; valves reniform; Honduras. (Grunow, *M. M. Jn.* xviii. 172, figs.)

Fig. 585.

Plagiochila asplenioides. Magnified 2 diam.

PLAGIOG'NATHA, Duj.—A genus of Rotatoria containing species included by Ehrenberg in the genera *Notommata*, *Diglena*, and *Distemma*; distinguished by the arched back and peculiar jaws.

BIBL. Duj. *Inf.* 651; Pritchard, *Inf.* 692.

PLAGIOGRAM'MA, Grev.—A genus of Diatomaceæ, family Fragilariæ.

Char. Frustules quadrangular, united into a short fascia; valves with two or more strong, pervious transverse costæ, and moniliform generally interrupted striæ.

BIBL. Greville, *Mic. Tr.* 1865, 1866; Rabenh. *Fl. Eur. Alg.* i. 117; Pritchard, *Infus.* 773.

PLAGIOPH'RYS, Clap.—A genus of Actinophryina (Rhizopoda).

Char. No carapace, pseudopodia numerous, arising from one point of the surface of the body. 2 species; freshwater. *P. cylindrica* (Pl. 52. fig. 17).

BIBL. Clap. et Lach. *Infus.* 453; Archer, *Qu. Mic. Jn.* 1871, 146.

PLAGIOPO'GON, St.—A genus of Holotrichous Infusoria. Free, oval, longitudinally furrowed, oral setæ rigid. *P. coleps*; length 1-300″. (Kent, *Inf.* 508.)

PLAGIOP'YLA, Stein.—A genus of Holotrichous Infusoria. Ovate; mouth ventral, with an undulating membrane; surface with trichocysts. 3 species; fresh and salt water. (Kent, *Inf.* 538.)

PLAGIOT'OMA, Duj.—A genus of Bursarina (Infusoria ciliata).

Parasitic; in the intestines and their walls of Vertebrata and Invertebrata, and in the mucus of Mollusca. 7 species. *P. lumbrici*, in the earthworm; *P. coli*, in the human intestine.

BIBL. Duj. *Inf.* 504; Clap. et Lach. *Infus.* 235.

PLAGIOT'RICHA, Kt.—A genus of Hypotrichous Infusoria; allied to *Oxytricha*. 2 species; freshwater. (Kent, *Inf.* 771.)

PLAGIOT'ROPIS, O'Meara.—A genus of Diatomaceæ closely allied to *Amphiprora*, Ehr.

BIBL. O'Meara, *Qu. Mic. Jn.* 1874, 88.

PLANA'RIA, Müll.—A genus of Annuloida, of the order Turbellaria, and suborder Planarida.

Char. Body soft, flattened, oblong or oval, not jointed, covered with vibratile cilia; neither suckers, bristles, nor leg-like appendages present.

Some parts of the structure of these animals have been noticed under ANNULATA in speaking of the Turbellaria. The mouth is situated on the under surface of the middle of the body, at the end of a retractile proboscis; there is no anus; the mouth leads to a capacious stomach giving off dendritically-branched cæca, somewhat as in one joint of a *Tænia* (Pl. 21. fig. 14). Their motion is continuous and gliding, upon water-plants, or the sides of glass jars. The anterior part of the body exhibits a curved row or a single pair of eyes, and sometimes ear-like projections. They multiply by division, and the formation of ova, which are enclosed in a coloured capsule.

Some of the species are very common in pools, and resemble, at first sight, minute leeches. *P. nigra*, which is black, has a row of marginal anterior eyes, and two lateral and one mesial projection; length about 1-2″. *P. brunnea*, dusky-brown, with a dark mesial line; eyes as above; length rather less. *P. lactea*, cream-coloured, tinged with pale reddish brown, truncate in front, with two slight lateral auricles; eyes two or four; length 1-2 to 3-4″. *P. torva*, grey or black; obtuse in front, angles rounded, centre projecting; eyes two, with a white halo; length 1-2″. Of the other species some are marine.

BIBL. Johnston, *Non-parasitical Worms*; Dugès, *Ann. Sc. Nat.* 2. xv. and xxi.; Œrsted, *System. d. Plattwürmer*; Diesing, *Helminth.*; Dalyell, *Powers of Creation*, ii.; Schultze, *Naturg. Turbell.*; Huxley, *Comp. An.*; Vaillant, *Mn. Mic. Jn.* i. 311; R. Lankester, *Pop. Sc. Rev.* 1867, vi. 388; Moseley, *Phil. Trans.* 1877, xvii. 105.

PLANARI'OLA, Duj.—A doubtful genus of Infusoria.

P. rubra (Pl. 31. fig. 65). Aquatic, in

decomposing vegetable matter; length 1-250″.

BIBL. Duj. *Inf.* 568.

PLANORBULI'NA, D'Orb.—A genus of Hyaline Foraminifera. Shell spiral, coarsely porous, subnautiloid or outspread, often parasitic; having from 15 to 200 chambers, with single septa and slight rudiments of the canal-system. Aperture sometimes produced and lipped. Complanate (*Pl. mediterranensis*, Pl. 24. fig. 10); plano-convex, *Truncatulina* (*T. lobatula*, Pl. 24. fig. 9); rotaliiform (*Pl. Haidingerii*, Pl. 24. fig. 6; *Pl. veneta*, fig. 12); or subnautiloid (*Anomalina* and *Planulina*). Smooth; limbate (*Planulina*); or granulate.

In all seas; fossil in the Carboniferous, Lias, and later formations.

BIBL. Carpenter, *For.* 206; Parker and Jones, *Phil. Tr.* clv. 379.

PLANTA'GO.—The common plaintain; its leaf and hairs furnish excellent examples of Cyclosis. See Carpenter, *Microscope*, p. 431.

PLANULA'RIA, Defrance.—A noticeable group of delicate, elongate, flattened *Cristellariæ*, connecting the nautiloid with the marginuline varieties, come under this name. Recent and fossil.

BIBL. Parker and Jones, *Ann. N. H.* 3. v. 114 (*crepidula*); xii. 215; 4. viii. 166.

PLANULI'NA, D'Orb.—A subgenus of *Planorbulina*; flat, discoidal, subsymmetrical, and with raised margins and septal lines (limbate). Recent and fossil.

BIBL. Carpenter, *Introd. For.* 207.

PLASMO'DIUM.—A sponge-like network, formed by the union of the pseudopodia of amœboid bodies.

PLAS'TIDS.—The simplest living forms, and the most elementary parts of tissues, consist of (1) small particles and masses of protoplasm without a nucleus or any trace of structure (our protoplasts, 1856), (2) of similar portions of protoplasm in which a nucleus has been differentiated. The first group Häckel terms Cytodes, the second cells; and both are grouped under the head of Plastids.

The cytodes, or the protoplasmic masses without a nucleus, are:—

Gymnocytodæ, or naked cytodes. Such are the freely moving *Monera*, the non-nucleated plasmodia of *Myxomycetes*, and of several other Protista, the amœboid germs of the *Gregarinæ* proceeding from the pseudo-naviculæ, &c.

Lepocytodæ, or covered cytodes. These are plasma-masses without a nucleus, enclosed in an entire or incomplete membrane or shell. For example, the encapsuled resting condition of many *Lepomonera*, many *Siphonæa*, and numerous other lower plants, and the so-called non-nucleated cells of many higher plants and animal tissues.

The cells or *cyta* are plasma-masses with a nucleus, and are divided into:—

Gymnocyta, naked cells. Such are the naked plasma-masses with a nucleus, but without a membrane or shell; for example, the true *Amœba*, the naked zoospores of Algæ, the eggs of Siphonophora, and other animals, the colourless blood-cells, many nerve-cells, &c.

Lepocyta, or covered cells. Such are the cells of animals, plants, and tissues with nuclei and cell-walls. See PROTISTA, CYTODE.

BIBL. Häckel, *Biol. Studien*, H. i.; *Qu. Mic. Jn.* 1869, 331; Hallier, *Plastids*, 1878.

PLAT'INUM.—The sodio-chloride of platinum crystallizes in prisms and plates which polarize light; while the potassio-chloride of platinum yields several forms, which do not polarize light. This reaction of the soda-salt has been proposed as a means of distinguishing soda from potash, or detecting minute quantities of the former.

BIBL. Andrews, *Chem. Gaz.* 1852, x. 378.

PLATYCE'RIUM, Desv.—A genus of Acrostichese (Polypodiaceous Ferns). 5 species; tropical. (Hooker, *Syn.* 425.)

PLATYCHE'LIPUS, Br.—A genus of Copepodous Entomostraca. *P. littoralis*; brackish water. (Brady, *Copep.*, *Ray Soc.* ii. 102.)

PLATYC'OLA, Kt.—Like *Vaginicola*, but the sheath decumbent, and attached by one side. Freshwater; several species. (Kent, *Inf.* 731.)

PLATYG'RAPHA, Nyl.—A genus of Graphidei (Lichenaceous Lichens). *P. rimata*, on ash trees, rare. (Leighton, *Lich. Flor.* 388.)

PLATYS'MA, Hoffm. — A genus of Ramalodei (Lichenaceous Lichens). 10 species, on rocky mountains &c. (Leighton, *Lich. Fl.* 93.)

PLATYTHE'CA, St.—A genus of Flagellate Infusoria. Ovate, with a decumbent rugose carapace; flagellum single; length 1-1200″; on *Lemna*. (Kent, *Inf.* 262.)

PLATYZO'MA, Br.—A genus of Gleicheniaceous Ferns. *P. microphyllum*, Australia. (Hook. *Syn.* 11.)

PLECA'NIUM, Reuss.—*Tertulariæ* with sandy shell-tissue come under this heading.

Bibl. Reuss, *Sitzungsb. Wien*, xliv. 383.

PLEOPEL'TIS, Humb. and Bonpl.—An exotic genus of Polypodieæ (Polypodioid Ferns), remarkable for the presence of peculiarly formed so-called paraphyses in the sori, performing the function of an indusium. These bodies are peltate, or like minute flat mushrooms or umbrellas expanded over and sheltering the sporanges (figs. 586, 587).

Fig. 586.

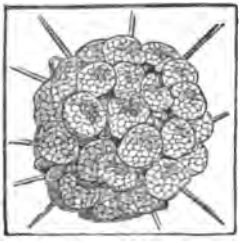


Fig. 587.

Pleopeltis nuda.
Fig. 586. A sorus, seen from above.
Fig. 587. Vertical section of ditto.
Magnified 25 diameters.

PLEUROCAR'PI.—Mosses with lateral fruits.

PLEUROCAR'PUS, Braun.—A genus of Zygnemaceæ (Confervoid Algæ).

2 species, in freshwater pools. (Rabenh. *Alg.* iii. 258.)

PLEUROCLA'DIA, Braun.—A genus of Fucoideæ, group Phæosporeæ. *P. lacustris*; freshwater. (Rabenh. *Alg.* iii. 393.)

PLEUROCOC'CUS, Meneg.—A genus of Palmellaceæ (Unicellular Algæ).

Char. Cells single or collected in globular or cubical masses, globular or angular from pressure, with a central nucleus; cytioderm thick and hyaline; cell-contents homogeneous, green or reddish. Multiplication by alternate fission in opposite directions. Gonidia formed in special cells. They present the greatest similarity to the gonidia of Lichens. Several species = forms of *Protococcus*?

Bibl. Meneg. *Nostoch.* 38; Nägeli, *Syst.* 124; Rabenh. *Alg.* iii. 24.

PLEURODES'MIUM, Kütz.—An obscure genus of Diatomaceæ, allied to *Striatella*; marine; Africa.

Bibl. Kütz. *Sp. Alg.* 115.

PLEUROM'ONAS, Perty.—A genus of Flagellate Infusoria.

Char. Reniform, extremely delicate, small, colourless; flagellum single, from the concave side of the body, three times its length. *P. jaculans*; motion jerking; stagnant water. (Perty, *Lebensf.* 171.)

PLEURONE'MA, Duj.—A genus of Holotrichous Infusoria, family Colpodina.

Char. Body oblong-oval, depressed, with a broad lateral orifice, from which a bundle of long, curved, floating and contractile ciliary filaments issue.

P. chrysalis, (*crassa*) D. (Pl. 31. fig. 66). Freshwater. Other species.

Bibl. Duj. *Infus.* 473; Clap. et Lach. *Inf.* 274; Kent, *Inf.* 542.

PLEUROPH'RYS, Clap.—A genus of Actinophryina (Rhizopoda).

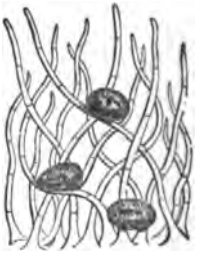
Char. Body invested with a sheath incrusted with extraneous siliceous particles.

P. sphærica. Freshwater.

Bibl. Clap. et Lachm. *Infus.* 454; Archer, *Qu. Mic. Jn.* 1870.

PLEUROPYX'IS, Corda.—A genus of Mucorini (Phycomycetous Fungi), growing

Fig. 588.



Pleuropyxis microsperma.
Magnified 200 diameters.

upon leaves and stems. This genus is imperfectly known.

Bibl. Corda, *Icon. Fung.* pl. 6. fig. 291.

PLEUROSIG'MA, Smith.—A genus of Diatomaceæ.

Char. Frustules single, free, longer than broad; front view linear or linear-lanceolate; valves navicular, sigmoid, with a longitu-

dinal line, and a nodule in the centre and at each end.

The median line and nodules consist of an internal thickening of the valves at the corresponding parts; the line is best seen in the front view (Pl. 15. fig. 16); it is occasionally found in a fractured valve, projecting as a solid highly refractive rod, the thinner adjacent portions of the valve being broken away; for brevity, it may be called the keel.

The valves exhibit spurious striæ, arising from the existence of rows of dots, of which we have already treated under DIATOMACEÆ. These striæ and dots are in most species very difficult to detect, requiring the use of oblique light, and the modern condensers with the stops; the principles which should guide in the search for them have been explained under ANGULAR APERTURE; the preliminary preparation of the valves is also essential (DIATOMACEÆ, p. 250).

Most of the species are found in salt or brackish water; a few in fresh water. They often abound upon the surface of mud. Conjugation or the formation of sporangia has not been observed. The frustules are sometimes found enveloped in amorphous mucus, and those of one species have been found within gelatinous tubes.

Many species have been described, of which those that have been used as TEST-OBJECTS will be enumerated. The measurements are mostly those of W. Smith and R. Beck, with which our own have coincided very nearly. The species are arranged according to the fineness of the markings, which coincides with the difficulty with which they are detected and resolved into dots; and the appended figures express the number of striæ or rows of dots in 1-1000″.

Striæ oblique (dots alternate or quincuncial, Pl. 15. fig. 40).

P. formosum (Pl. 15. fig. 25). Broadly linear, attenuated towards the ends; sigmoidure evident; keel oblique; length 1-60″; striæ 36. Marine.

P. decorum (Pl. 15. fig. 26). Rhomboid-linear; attenuated; sigmoidure very evident; keel oblique; length 1-90″; striæ 36. Marine.

P. speciosum (fig. 28). Linear-lanceolate; sigmoidure resulting from the curvature of one margin of each half of the valve, the opposite margin of each respective half being nearly straight; keel in each half forming two curves; very oblique near the ends; length 1-90″; marine; striæ 44. The halves of the valves somewhat resemble the blade of a pocket-knife.

P. strigosum (fig. 29). Linear-lanceolate; ends rather obtuse, sigmoidure slight; keel nearly straight in the middle, curved near the ends; length 1-90″; striæ 45. Marine. Fig. 40 represents the striæ resolved into dots.

P. quadratum (fig. 34). Rhomboidal, acuminate at the ends; sigmoidure evident towards the ends; keel curved, nearly median; length 1-150″; marine; striæ 45.

P. elongatum (Pl. 15. fig. 31, and Pl. 1. fig. 18). Linear-lanceolate, acuminate; sigmoidure slight, uniform; keel median; length 1-80″; marine; striæ 48.

P. rigidum (fig. 30). Linear-lanceolate, obtuse at the ends; sigmoidure slight; keel nearly median; length 1-70″; marine; striæ 48.

P. angulatum (Pl. 15. fig. 33). Rhomboid-lanceolate or angular-lanceolate; sigmoidure evident; keel nearly median; length 1-110″; marine; striæ 52. Pl. 1. fig. 16 represents a valve with the striæ resolved into dots; Pl. 15. fig. 41 represents the dots very highly magnified; and Pl. 15. fig. 46 exhibits the appearance of hemispherules, which some authors consider to form the true structure.

Pl. 15. fig. 33*a* represents a specimen with the endochrome and nucleus.

β (fig. 33*b*). Simply and narrowly lanceolate, ends acute.

γ (fig. 33*c*). Ends beaked; abruptly flexed.

P. æstuarii (fig. 35). Lanceolate; ends abruptly tapering, short and beak-like; sigmoidure evident; keel not median; length 1-250″; marine; striæ 54.

P. intermedium (fig. 36). Narrowly linear-lanceolate, acute; sigmoidure none, or merely indicated by a slight inequality in the opposite margins of the valves; keel nearly straight and almost median; length 1-140″; marine; striæ 55.

β *P. nubecula.* Ends obtuse; slightly more lanceolate, and shorter; marine; striæ 55.

P. delicatulum (fig. 32). Very narrowly linear-lanceolate; sigmoidure evident; keel nearly central; marine; length 1-130″; striæ 64.

P. obscurum (fig. 27). Linear, attenuated near the ends; sigmoidure slight;

principally arising from the curvature of one margin of each half of the valve; keel not median, especially near the ends; marine; length 1-200″; striæ 75.

Striæ longitudinal and transverse (dots opposite, Pl. 15. figs. 39, 42).

In most of the following species or forms the dots are not equidistant in the longitudinal and transverse rows.

P. strigilis (fig. 12). Linear-lanceolate; sigmoidure evident; keel nearly median, flexure double; marine; length 1-75″; striæ: longitudinal 40, transverse 36.

P. balticum (fig. 10). Broadly linear, narrowed at the ends; sigmoidure apparent at the ends only and produced principally by the curvature of one margin only; keel not median, flexure double; marine; length 1-80″; striæ, both sets, 38. Fig. 39, piece of valve, showing dots.

β. Gradually tapering towards the ends; striæ obscure.

P. Hippocampus (fig. 13). Narrowly lanceolate, gradually attenuated towards the broad, very obtuse ends; sigmoidure evident; keel nearly median; marine or brackish water; length 1-100″; striæ: long. 32, tr. 40.

P. attenuatum (fig. 15. Pl. 1. fig. 17). Linear-lanceolate, with obtuse ends; sigmoidure slight; keel nearly median; marine and freshwater; length 1-120″; striæ: long. 30, tr. 40.

P. lacustre (fig. 18). Linear-lanceolate, ends rather obtuse; sigmoidure evident; keel almost median; freshwater; length 1-130″; striæ, both sets, 48.

P. tenuissimum (fig. 24). Narrowly linear, attenuate towards the ends; sigmoidure evident; keel nearly central; freshwater; length 1-180″; striæ, both sets, 48.

P. Spencerii (fig. 17). Linear-lanceolate; sigmoidure evident; keel nearly median; freshwater; length 1-200″; striæ: long. 55, tr. 50.

P. littorale (fig. 19). Lanceolate, ends somewhat prolonged; sigmoidure evident; keel median; freshwater; length 1-180″; striæ: long. 24, tr. 50. Fig. 42 represents the dots upon part of a valve.

P. acuminatum (fig. 14). Linear-lanceolate, acuminate; sigmoidure evident; keel median; freshwater; length 1-150″; striæ: long. 40, tr. 52.

P. fasciola (fig. 21). Linear-lanceolate; with linear beak-like ends; sigmoidure evident; marine; length 1-200″; striæ: long. (?), tr. 64.

P. prolongatum (fig. 23). Very narrowly linear-lanceolate, acuminate, with linear beak-like ends; sigmoidure present in the ends only; keel nearly median; marine; length 1-200; striæ: long. (?), tr. 65.

P. distortum (fig. 20). Lanceolate; ends slightly produced and beak-like; sigmoidure evident; keel central; marine; length 1-300″; striæ: long. 65, tr. 75.

P. macrum (fig. 22). Very narrowly linear-lanceolate; ends produced into long beak-like processes; sigmoidure produced by the ends of the beaks only; keel median; length 1-100″; marine; striæ: long. (?), tr. 85.

Bibl. Hassall, *Freshwater Algæ*, 435; Smith, *Brit. Diatom.* i. 61; Kützing, *Sp. Alg. and Bacill.*; Rabenhorst, *Alg.* i. 230 (46 European species); and the Bibl. of Diatomaceæ.

PLEUROSTAU'RUM, Rab. = *Stauroneis* united into filaments.

Bibl. Rabenh. *Alg.* i. 258; O'Meara, *Qu. Mic. Jn.* 1872, 387.

PLEUROTÆ'NIUM, Nägeli.—A genus of Desmidiaceæ, consisting of species of *Closterium*, *Docidium*, and *Penium*.

Bibl. Rabenh. *Fl. Eur. Alg.* iii. 140.

PLEUROT'RICHA, Stein.—A genus of Hypotrichous Infusoria. Like *Stylonychia*, but without caudal setæ, with larger ventral setæ, and the anal styles in two groups. 3 species; freshwater. (Kent, *Inf.* 782.)

PLEUROT'ROCHA, Ehr.—A genus of Rotatoria, of the family Hydatinæa.

Char. Eyes none; a single tooth in each jaw; foot forked (= *Hydatina* with unidentate jaws).

P. gibba (Pl. 44. fig. 18). Body ovate-oblong, truncate in front; toes small, turgid. Freshwater; length 1-216″.

Bibl. Ehr. *Infus.* 418; Gosse, *Ann. N. H.* 1851, viii. 199.

PLEUROX'US, Baird. — A genus of Entomostraca, of the order Cladocera, and family Lynceidæ.

Char. Anterior part of shell prominent above, obliquely truncate below; first pair of legs very large; beak sharp, curved downwards. Freshwater.

P. trigonellus (Pl. 19. fig. 32). Beak long, sharp-pointed, slightly curved downwards; inferior antennæ short and slender, anterior branch with four setæ, one from the first joint, one from the second, and two

from the last; posterior branch with three setæ, all arising from the last joint.

P. uncinatus. Beak curved upwards at the end; 3 sharp spines at anterior inferior angle of shell; inferior antennæ as the last.

P. hamatus. Beak blunt and strong, slightly curved downwards; first pair of legs with a curved claw at the end. ? Male of *P. trigonellus.*

BIBL. Baird, *Brit. Entomostr.* p. 134.

PLOCA'MIUM, Lamouroux.—A genus of Delesseriaceæ (Florideous Algæ), containing one species, *P. coccineum* (Pl. 4. fig. 10), the commonest of our red seaweeds, with a delicate flat feathery thallus, from 2 to 12″ high, growing in bushy tufts on rocks or other Algæ. The fruit consists of:—1. *coccidia,* spherical, stalked or sessile tubercles, at the sides or in the axils of the ramules, filled with angular spores; 2. *antheridia,* which occur in inconspicuous flat patches, composed of short erect cells, upon the surface of distinct plants; and 3. *stichidia,* lateral or axillary, simple or branched pods containing a single or double row of linear (transversely parted) tetraspores.

BIBL. Harvey, *Mar. Alg.* 19; *Phyc. Brit.* pl. 44; Grev. *Alg. Brit.* pl. 12; Thuret, *Ann. Sc. Nat.* 4 sér. iii. 19.

PLŒO'TIA, Duj.—A genus of Infusoria, family Thecamonadina.

Char. Body diaphanous, with several longitudinal ribs or keels in the middle, and a rounded perfectly limpid margin. Two anterior locomotive filaments, one flagelliform, the other trailing and capable of arresting the movement of the body.

P. vitrea (Pl. 31. fig. 67). Marine; length 1-1200″. Movement slow.

BIBL. Duj. *Infus.* 345.

PLŒSCO'NIA, Duj., = *Euplotes,* Ehr.

PLUMATEL'LA, Lamk.—A genus of freshwater Polyzoa, order Hippocrepia, family Plumatellidæ.

Char. Zoary confervoid, branched, tubular, branches distinct; tentacular disk crescentic; ova elliptical, with a marginal ring, but no spines.

P. repens. Zoary irregularly branched; cells subclavate, without a longitudinal furrow or keel; tentacles about 60; tentacular membrane dentate; ova broad.

a. Adherent throughout.

β. Attached only at the base.

P. fruticosa. Irregularly branched, attached at the origin only; cells cylindrical, and destitute of furrow, but obscurely keeled; ova elongated.

P. coralloides. Attached at the base only; tubes dichotomous, densely tufted, destitute of furrow and keel; tentacles about 60; ova broad.

BIBL. Allman, *Freshw. Polyz.* 92; *Ann. N. H.* 1844, xiii. 330; Johnston, *Br. Zooph.* 402; Parfitt, *Ann. N. H.* 1866, xviii. 171.

PLUMULA'RIA, Lamk.—A genus of Hydroid Zoophytes, family Plumulariidæ.

Char. Polypidom plant-like, rooted, simple, or branched, feathery; cells small, unilateral, usually seated in the axilla of a horny spine; egg-vesicles scattered. Ten British species.

P. cristata. Stem simple, a single tube, pinnate; pinnæ alternate; cells close, rim toothed; vesicles gibbous, girt with crested ribs.

P. falcata. Stem a single tube, waved, branched, branches alternately pinnate; cells close, shortly tubular, rim entire; egg-vesicles oval-oblong; common.

In *P. myriophyllum* & *P. frutescens,* the stem consists of several parallel tubes.

P. pinnata, Linn. Stem a simple tube, plumose; pinnæ alternate, three on each internode; cells rather distant, campanulate, appressed, rim entire; vesicles pear-shaped, rim toothed.

P. setacea, Ellis. Stem a single tube, pinnate; pinnæ alternate, one at each joint; joints ringed; cells very remote, campanulate, rim even; vesicles elliptical, smooth; common.

BIBL. Johnston, *Br. Zooph.* 89; Hincks, *Hyd. Zooph.* i. 294.

PLUMULARI'IDÆ.—A family of Hydroida.

BIBL. Hincks, *Hyd. Zooph.* i. 279.

PODAXINE'I.—A family of Gasteromycetous Fungi, none of which are found in Britain; they are distinguished from all allied tribes by a solid column in the centre of the sporange.

Many of the species grow on the hills of the White Ant.

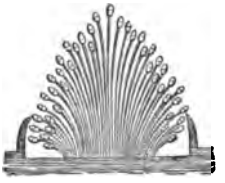
BIBL. Montagne, *Ann. Sc. Nat.* 2. xx. 69; Tulasne, *Ann. Sc. Nat.* 3. iv. 169; Currey, *Linn. Tr.* xxvi. 288.

PODISO'MA, Link.—A genus of Uredinei (Hypodermous Fungi), growing upon the living leaves and branches of species of Juniper; the filamentous mycelium creeping beneath the epidermis, and sending up a fleshy, stalk-like, tremelloid body (fig. 589), composed of agglutinated filaments (fig. 590) terminating in bilocular spores (or two spores adherent together), each of the cells

having two or four pores, through which the internal membrane is protruded in germination.

Fig. 589.

Fig. 590.



Podisoma Juniperi.

Fig. 589. Branch of Juniper with clavate fructification protruded from beneath the bark. Nat. size.
Fig. 590. Vertical section through a fruit, showing the filaments terminating in bilocular spores. Magnified 50 diameters.

Four species are described as British: *P. Juniperi-communis*, *P. Jun.-sabinæ*, *P. foliicolum* (on the leaves of *J. communis*), and *P. fuscum* on *Pinus halepensis* and *oxycedrus*.

It has been supposed, but perhaps without sufficient grounds, that the *Podisoma* of Savine is a condition of *Rœstelia cancellata*.

PODOCOR'YNE, Sars. — A genus of Hydroid Zoophytes. 2 species; on stones and shells, deep water.

Bibl. Sars, *Faun. Litt. Norv.* i, 4, t. i.; Allman, *Ann. N. H.* 1859, 1864; Hincks, *Hyd. Zooph.* 27; Agassiz, *Sea-side Studies*, 1871.

PODOCORYN'IDÆ.—A family of Hydroid Zoophytes.

Char. Polypes sessile, with a single whorl of filiform tentacles around the base of a conical proboscis; mouth simple. Gen.: *Podocoryne* and *Corynopsis*.

Bibl. Hincks, *Hyd. Zooph.* 27.

PODOCY'ATHUS, Kt.—Like *Podophrya*, but with two kinds of tentacles, prehensile and suctorial. *P. diadema*, marine, length 1-600″. (Kent, *Inf.* 827.)

PODOCYS'TIS, Ktz.—A genus of Diatomaceæ, Cohort Surirelleæ.

Char. Frustules sessile, cuneate; valves convex, obovate, with a median line, transverse continuous, and intermediate granular striæ.

P. americana, Bailey (Pl. 51. fig. 7). The only species; marine = *P. adriatica*, Ktz. = *Doryphora elegans*, Roper.

Bibl. Bailey, *Smith. Contr.* 1854; Ktz. *Bac.* 62; Roper, *Mic. Jn.* ii. 284; Rabenht. *Alg.* i. 60.

PODOCYS'TIS, Lév. = *Melampsora*. See Uredinei.

PODODIS'CUS, Kg.—A genus of Diatomaceæ.

Char. Frustules single or concatenate, with a marginal stalk; valves circular, convex. Marine. No markings visible under ordinary illumination.

P. jamaicensis (Pl. 17. fig. 16). Stalk elongate, weak. Diameter 1-840″.

Bibl. Kütz. *Bacill.* 51; *Sp. Alg.* 26.

PODOPH'RYA, Ehr.—A genus of Acinetina.

Char. Suckers simple, capitate, in bundles or on the surface, neither on a trunk nor ramified; body without a shell, pedunculated. Several species, freshwater and marine; *P. fixa* (Pl. 30. fig. 5, *a* & *b*).

Bibl. Ehr. *Inf.* 305; Clap. et Lach. *Inf.* 381; Kent, *Inf.* 813; Gegenbaur, *Morph. Jahrb.* 1875.

PODOSI'RA, Ehr.—A genus of Diatomaceæ.

Char. Frustules concatenate, with a lateral stalk; valves circular, punctate, convex. Marine. Stalk attached to the centre of the valves.

P. hormoides (Pl. 19. fig. 34). Frustules 2 to 6, depressed-spheroidal, connected by isthmi or stalks; hoops obscurely punctate. Diameter 1-650″.

P. Montagnei (*Melosira globifera*, Ralfs). Frustules usually 2; hoops striate. Diam. 1-600″.

P. maculata, Smith, *Diat.*

P. compressa, West, *Pritch. Inf.* 815.

P. lævis, Gregory, *Mic. Jn.* vii. 85.

Bibl. Kütz. *Sp. Alg.* 26; Smith, *Br. Diat.* ii. 53; Rabenh. *Alg.* i. 37.

PODOSPHE'NIA, Ehr.—A genus of Diatomaceæ.

Char. Frustules attached, sessile, wedge-shaped in front view; ends indented so as to produce a black line (vitta) in the front view; valves convex, obovate, with a longitudinal median line and transverse striæ, but no nodules. Marine.

The striæ consist of rows of dots, sometimes distinct by ordinary illumination, at others not so.

P. Ehrenbergii (Pl. 17. fig. 17). Frustules truncate at the end in front view; valves somewhat acute at the ends; length 1-240″.

P. Lyngbyei. Fr. truncate in front view; valves rounded at the end; length 1-350″.

Three other British species.

BIBL. Smith, *Br. Diat.* i. 82; Kütz. *Bacill.* 119; Rabenhorst, *Alg.* i. 110.

PODOSPO'RIUM, Lév.,= *Melampsora.* See UREDINEI.

PODOS'TOMA, Clap. et Lach.—A genus of Amœbæa (RHIZOPODA).

Char. Bodies amœboid, with 2 kinds of pseudopodia, one the ordinary, the others terminating in a flagellum.

P. filigerum, among aquatic plants.

BIBL. Clap. et Lach. *Inf.* 441; Kent, *Inf.* 224.

PODU'RA, L.—A genus of Insects, order Thysanura, family Podurellæ.

The original genus has been greatly subdivided. In its extended signification, the characters consist in the thorax being distinct from the abdomen, and in the presence of a forked tail, bent under the abdomen when not in use, and enabling the animals to move by springing or jumping, whence the common name of spring-tails applied to them.

They are of a leaden appearance, and found in shady damp places, as under flower-pots or stones, in cellars, &c., and are about 1-20 to 1-10″ in length. They may be caught by placing a little flour upon a piece of paper in their haunts.

Fig. 591.

Podura.

Magnified about 15 diameters.

The body is covered with scales (Pl. 1. fig. 12), which are used as test-objects. Those of the so-called *P. plumbea*, which is now described as a *Lepidocyrtus*, are usually recommended; but the most common *Podura* is not this species. This, however, is a matter of little importance, because the scales of several species, belonging to even different genera, are similar both in form and markings.

See SCALES OF INSECTS and TEST-OBJECTS.

BIBL. Gervais, *Walckenaer's Aptères*, iii. and the *Bibl.*; M'Intire, *Mn. Mic. Jn.* i. 203; 1870, 1; Beck, *Mic. Tr.* 1862, 84; Lubbock, *Thysanura, Ray Soc.*

PODURHIP'PUS, Mégn.—A genus of Thysanura, fam. Podurellæ. *P. pityriasicus*; body fusiform, black, legs paler; producing prurigo in horses. (Mégnin, *Paras.* 104.)

PLEUROCHILID'IUM, Stein.—A genus of Holotrichous Infusoria. Free, no carapace, subreniform, mouth with a narrow undulating membrane. *P. strigilatum*, among *Lemnæ*. (Kent, *Inf.* 540.)

POLARISCOPE.—A term employed to designate a polarizing apparatus, consisting of a polarizer and analyzer. See INTRODUCTION, p. xx.

POLARIZATION OF LIGHT.—The phenomena exhibited by microscopic objects, when viewed by polarized light, are perhaps the most beautiful and interesting of those connected with the use of the microscope. The extreme brilliancy, transparency, and variety of the colours developed cannot be equalled; much less can they be represented by illustrations, although the figures in Pl. 39 may give some idea of the manner in which they are arranged in certain objects.

The ordinary arrangement of the parts of the polarizing apparatus scarcely needs description,—the polarizer being placed beneath the object and the analyzer above it, the polarizer and analyzer usually consisting of two Nicol's prisms, although two plates of tourmaline are sometimes used. Some artificially prepared crystals exert a powerful polarizing action, and may be used either as polarizers or analyzers, or as both; among these the salt of QUININE called Herapathite occupies the first place. Others form interesting analyzers, some of which have been noticed under ANALYTIC CRYSTALS and DICHROISM.

Numerous salts and other crystalline bodies, which powerfully depolarize the already polarized light, and exhibit beautiful colours, are mentioned under their respective heads; some of these may be enumerated here—as the oxalate of ammonia, of soda, and of chromium and ammonia, the oxalurate of ammonia, the acetate of copper, chlorate of potash, the prismatic form of the ammonio-phosphate of magnesia, the ammonio-phosphate of soda, the sulphates of cadmium and of magnesia, selenite, salicine, fused santonine, uric acid, &c.

Many animal bodies and tissues also possess considerable depolarizing power, and

form beautiful microscopic objects — as horse-hair, portions of feathers, sections of quill, of hoof, horn, fish-scales (salmon), &c.

The influence of vegetable structures on polarized light has been thoroughly investigated by Mohl, whose interesting account we are able to confirm, and a brief notice of it is desirable here; but the observations apply equally to the more feebly anisotropous tissues of animals. As it is desirable to obtain as much light as possible, a glass prism is preferable to the ordinary mirror for illumination; Nicol's prisms are better than tourmaline or Herapathite for the polarizer and analyzer; and the latter should be as large as possible. Further, the light emerging from the polarizer should, if possible, be condensed by an achromatic of large aperture; or the condensation may be effected by a hemispherical flint-glass lens, 5 lines in diameter, having its plane face turned towards the object. The object-glasses must be of large angular aperture; a power of 4-10″ is sufficient for most objects; but 1-4″, and even 1-8″ object-glasses may be made to transmit sufficient light. It is requisite to provide plates of the doubly-refracting substances mica and gypsum, mounted so that they can be inserted between the polarizer and the condenser, and revolved horizontally while so placed. Those of mica are used for detecting weak degrees of doubly-refracting power, being of such thickness as to give a grey field with a white or black object when the prisms cross. The thin laminæ, of which six may be provided, from the thinnest possible up to 1-20‴, should be cemented with Canada balsam between glass plates. For obtaining colours, plates of gypsum, similarly mounted, are best. Mohl prefers such as give a red field, and provides plates of different thickness, giving the reds of the different orders of Newton's rings.

It is easy to ascertain whether an organic body shows positive or negative colours, by comparing its colour, when seen with a plate of gypsum in a certain definite position, with the colour given under the same circumstances by a strip of glass brought into a state of tension by slight bending, or with the colours of a suddenly-cooled globule of glass. In this way the author determined that the fibres of a spiral vessel displayed negative colours, and the laminæ of a starch-corpuscle positive colours, and then applied these organic structures, by comparison, for ascertaining the properties of other objects. The objects to be examined should be mounted in a liquid or other substance rendering them as transparent as possible, such as glycerine, Canada balsam, or an essential oil.

When ordinary globular or cylindrical cellular tissues are viewed by cross sections, their substance is seen to be doubly refractive; for when the prisms cross, the circular sections of the cell-walls appear like rings of bright light on a black ground, but with the ring divided into four quadrants by dark stripes, as if a black cross lay over it; when the prisms are placed parallel, the parts of the section previously bright appear dark, and *vice versâ*, on a bright field. If a section of polyhedral cellular tissue is viewed in the same way, the appearances are somewhat different, since the cut edges are here straight lines, variously inclined towards the prisms; those which are perpendicular to the prisms are invisible, while those standing obliquely are bright in their whole length. In general, cell-membrane acts more powerfully on the light the denser its substance, and soft collenchymatous tissues are far less powerfully doubly-refractive than wood-cells. When the cells have the walls much thickened, it is common for the primary cell-membrane to be much more powerfully refractive than the secondary layers. The influence of cellulose membranes upon polarized light is not much affected by bleaching them with nitric acid and chlorate of potash (Schultze's reagent). It has been supposed that the remarkable effect produced by the epidermis of *Equisetum hyemale* is attributable to the silex present; but Mohl finds the action greatly weakened by destroying the organic matter by a red heat. But this heating does not remove the power there, nor in the Diatomaceæ, of which Mohl confirms Bailey's statement, in contradiction to Ehrenberg, that various species of *Navicula*, *Synedra*, *Pleurosigma*, and *Melosira* are decidedly doubly refractive.

Very remarkable phenomena are produced when the polarized light is made to pass through plates of mica or selenite. In the first place, thin plates of mica often allow of the discovery of a doubly-refracting power too feeble to be detected by the prisms alone—the degree of illumination of the object being slightly different from that of the field on which it is viewed. But the

most important matter is the revelation, by the use of the selenite plates, of the existence of positive and negative characters, like those of positive and negative crystals, in the chemically distinct constituents of vegetable tissues.

Let us suppose that between the lower prism and the object is placed a plate of selenite giving a red field; the plate is then rotated so that its neutral axes are at an angle of 45° with the prisms. A section of a cylindrical vegetable cell will be seen to be divided into four quadrants: the two alternate quadrants, whose middle lines correspond to the neutral axes of the selenite, are either blue or green, the other two yellow or red: if the selenite is then rotated so that its neutral axes are perpendicular to the prisms, the colours will be all lost; but on continuing the rotation, they reappear in the reverse order—what was blue appearing yellow, and *vice versâ*. When the walls are rectilinear, all the cell-walls perpendicular to one of the prisms will give the colour of the field, all those which run parallel with one of the neutral axes of the selenite plate, or form no great angle with it, will be blue, those parallel with the other axis yellow.

It is found that vegetable structures fall into two classes in reference to these colours, in one of which classes all layers lying obliquely in the direction of a right-wound screw are tinged blue and yellow, those oblique in the opposite direction yellow or red; in the other class, the colours under the same conditions are just the reverse; so that one class are optically positive, the other optically negative.

The optically negative are the ordinary cell-membranes of the internal organs of plants, whether in their natural condition or cellulose purified by the help of nitric acid and chlorate of potash: collenchyma, horny endosperm-cells, the gelatinous cells of Algæ, &c., all agree in this property. Optically positive colours are given by cell-membranes of periderm and the cuticular layers of epidermal cells. The contrast of the positive and negative colours of the cuticle and other parts of the cell-wall is well seen in the epidermis of *Aloe*. The diversity of colouring under polarized light here corresponds to the diverse behaviour under treatment with iodine after maceration in solution of potash (SECONDARY DEPOSITS).

The longitudinal sections of all behave like the cross sections; but the appearances are not so clear. When side views of the surface of cells are obtained, the phenomena are very varied; but these are best seen in vessels or ducts when the thickening layers are in the form of spiral bands. Thus, if one of the spiral vessels of *Musa* is placed (its spiral somewhat drawn apart) with its long axis perpendicular to one of the prisms, the fibres on the upper side turn to the left, those on the under side towards the right; and when the selenite plate is interposed, they exhibit the complementary colours. When the side walls of cells have obscure striation, as in the cells of Conifers, the liber-cells of Apocyneæ, &c., the membrane gives evidence of its fibrillar structure by the yellow or blue colour developed with the selenite plate. If fibres of a spiral vessel cross at right angles, and they are pressed together, they neutralize one another where they cross: when the prisms are used alone, the crossing points are black, the rest of the fibres white; when the selenite plate is interposed, the crossing points exhibit the colour of the field, and the uncrossed portions of the fibre are blue or yellow according to position.

The vicinity of a round bordered pit, as in the wood-cells of *Pinus*, exhibits a black cross when seen perpendicularly by polarized light. The black cross and the colours exhibited by starch are well known. Chlorophyll does not seem to act on polarized light, nor the primordial utricle of cells, except a trace when contracted by weak alcohol.

The polarization apparatus is exceedingly useful for the detection of crystals (RAPHIDES) in vegetable tissues, when they are so small as to be easily overlooked; and the larger kinds form beautiful objects with, and often without the selenite plate.

BIBL. Herschel, *Encycl. Metrop.* art. *Light*; Pereira, *Lect. on Pol. Light, by B. Powell*; Brewster, *Optics*; Erlach, *Beobacht. üb. organ. Element. bei polar. Licht, Müller's Archiv*, 1847; Valentin, *Untersuch.* 1861; Lobb, *Qu. Mic. Jn.* viii. 107; Carpenter, *The Microscope*; Beale, *How &c.*; Davies-Matthews, *Mounting &c.*

POLLEN.—This name is applied to the coloured pulverulent substance familiar to every one as occurring scattered in the interior of full-blown flowers; it is produced in the anthers, the (usually) stalked club-shaped organs which stand in one or more circles between the floral envelopes and the pistils, and is discharged from them when

ripe, in order to fertilize the ovules. When slightly magnified, the pollen of most flowers appears to consist of granules, of different size and colour in different plants; hence the individual particles are called *pollen-grains* or *granules* (Pl. 40). Examination under a sufficient magnifying power shows that the simple or typical forms of pollen-grains are single free cells filled with fluid matter: more complex forms occur in many cases, which, however, may be simply characterized as simple pollen-grains, permanently coherent into definitely-formed groups.

The pollen-grain may be examined as to its form and stucture, its contents, and its development.

The forms of simple grains presented in different plants are tolerably varied—spherical (Pl. 40. figs. 8–10, 22, 23, 25) and elliptical (figs. 6, 11, 29) being perhaps those most common; but besides these, numerous geometrical forms occur, such as tetrahedral (fig. 14), polygonal (figs. 16, 27, 28), cubic (fig. 19). But it must be noted here that the forms frequently vary according as the pollen is viewed dry or in fluid, since the elliptical and allied forms often expand into a spherical form, when they absorb liquid (figs. 18 & 20 *a*, *b*, *c*). The explanation of this will be given presently. The external appearance is further greatly influenced by minor peculiarities of form, such as ridges, spines and processes of different kinds; these, however, are referable to the structure of the outer coat.

The ordinary structure of the coats or the cell-wall of the pollen-grain is that of a delicate internal cell-membrane, with an outer, thick and resisting layer, which may be regarded as the Cuticle of the inner or proper membrane of the cell. In a few cases the inner membrane alone exists, as in the cylindrical pollen-cells of *Zostera* and some other aquatic plants. In other cases the outer or cuticular coat presents a more complex structure, and two, or, it is said, even three layers may be distinguished in it; these, however, seem to be merely a lamination of the outer coat. The conditions in some of the Coniferæ are different from this, and will be alluded to presently. The inner membrane is exceedingly delicate and homogeneous: in ordinary spherical or oval grains it accurately lines the outer coat; in some of those forms which present processes of various kinds, such as *Œnothera*, it seems to us that the inner coat does not extend into these processes in the mature pollen. The outer coat exhibits, as to surface, every variety of appearance, from smooth, through granular and spiny, to pseudo-cellular arising from reticulated ridges; in addition to this, the processes just alluded to give a very peculiar aspect to many kinds of pollen. Besides these, we find in all cases markings appearing like *pores*, or others like *slits* (which become *furrows* when dry), or both together, and these in varying number in different cases. The colour of the pollen presents great differences; although usually yellow, it may be whitish, red (*Verbascum*), blue (*Epilobium angustifolium*), even black (tulip): this colour resides in the outer coat. The outer coat also exhibits, in the majority of cases, a secretion upon its surface, of a viscid character, usually described as oily, but apparently consisting of a viscid matter not readily soluble in water, remaining from the dissolved parent cells. It would seem to be the substance which holds together the pollen-grains in those cases where it consists of waxy masses, readily breaking up into small fragments (Ophrydeous Orchids). In the Onagraceæ the pollen-grains are loosely connected by slender viscid filaments, which appear to be derived from the same source.

The more detailed explanation of the character of the pores &c., the projecting processes, and the compound conditions of pollen will be understood better after a sketch of its development.

The anther, in which the pollen is formed, consists in its younger stages of a minute, solid, cellular papilla or cylindrical body. At an early period a distinction becomes manifest in its cells: a single vertical row, lying in the position of the axis of each pollen-chamber (or loculus), presents a different aspect, from its cells exceeding the surrounding ones in size; and these rows undergo a special development to produce the pollen-grains, while the surrounding layers are developed into the tissues forming the coat or wall of the anther, and its mid-rib or *connective* (see Anther). The cells of the primary row multiply by cell-division with the general increase in size of the anther (figs. 592–594), until at length they form relatively large masses of cellular tissue composed of large squarish cells filled with granular contents, well defined as constituting a distinct tissue from the walls of the pollen-chambers. A new

Fig. 592.

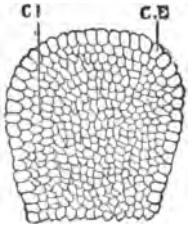


Fig. 593.

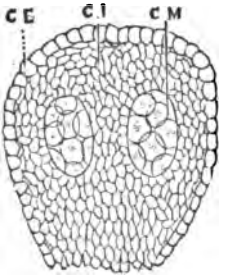


Fig. 594.

Vertical sections of a cell of a young anther of the Melon, showing the gradual separation of the regions. *C E*, epidermal cells; *C I*, cells of the wall of the anther; *C L*, cells lining the loculi; *C M*, cells from which the pollen is developed.

Magnified 100 diameters.

change then takes place: the contents of each cell secrete a layer of cellulose, which does not adhere to the wall of the parent cell to form a layer of secondary deposit, but lies free against it, so that a new free cell is formed within each old one, nearly filling it. The walls of the old cell (forming a connected parenchymatous tissue) then dissolve, so that the new cells become free, no longer merely in their parent cells, but in a cavity which is to constitute the pollen-chamber or loculus of the anther. These free cells are the *parent cells of the pollen* of authors. A new phenomenon soon occurs in these. These parent cells divide into four by ordinary cell-division, either by one or by two successive partings by septa at right angles to each other but both perpendicular to an imaginary axis (as when an orange is quartered), or by simultaneously-formed septa which cut off portions in such a manner that the new cells stand in the position of four cannon-balls piled into a pyramid (tetrahedrally). These new cells are the *special parent cells* of the pollen; and in each of these the entire protoplasmic contents secrete a series of layers, which in the ordinary course, by the solution of the primary walls of the special

Fig. 595.

Fig. 596.

Fig. 597.

Pollen-grain of the Melon in various stages of development.

Magnified 100 diameters.

parent cells upon which they were applied, become the walls of free cells, which constitute the simple ordinary pollen-cells. These subsequently increase in size; and their outer laminæ assume the characteristic form and appearance while free in the chamber of the anther (figs. 595–597).

In referring the peculiarities of many kinds of pollen to circumstances connected with the development, it may be noted in the first place, that the mode of division of the parent cells into quarters often influences the ultimate form of the pollen-grain: thus, when the division is by two planes at right angles, the original form of the pollen-grain will be elongated, and the ripe grain will probably be elliptical, while, when the division is "tetrahedral," the grains may retain the form thus produced, or be slightly modified and become polygonal, or, as is more common, they expand more readily than the others into a sphere. But there is no absolute rule here; we find even the tetrahedral and the polar division occur together among the parent cells of the same anther. In the next place, a compound condition of the pollen-grains (Pl. 40. figs. 7, 17) is readily explicable by referring it to an arrest of the process of subdivision; so that if the walls of the special parent cell do not dissolve, the pollen-grains will be left in groups of four; and if the parent cells do not become singly detached in the

antecedent process of solution, the grains may be still developed in the same order and manner and remain connected in greater or smaller masses or groups, each enclosed in its special parent cell, itself connected with a number of others of the same generation by the persistence of the walls of the cells in which the parent cells were developed. This explains the compound pollen of the Acacias (Pl. 40. fig. 25), and, as an excessive form, the waxy pollen-masses which occur in the Orchidaceæ and Asclepiadaceæ. It is sometimes stated that the pollen-grains of these compound forms are merely connected together by the viscid substance remaining from the solution of the parent cells; but this would render such cohesions indefinite in character, instead of being regular; at the same time it will be understood that the solution may have advanced so far that the grains merely hold together slightly, and may readily be separated. This is not the case, however, with the majority of compound pollen-grains. When pollen-grains do become free, the viscidity of their surface is probably referable to the dissolved parent cells.

The metamorphoses of the outer coat or cuticle of the pollen-grain are very remarkable, and not yet at all understood; the granulations (Pl. 40. figs. 11, 12), spines (figs. 8, 9, 22, 26), reticulations (figs. 13, 23, 27, 28), &c. characterizing mature grains make their appearance in the interval between the solution of the special parent cells and the bursting of the anther, while the pollen-grains lie free within the latter; their production is accompanied by a general growth and expansion of the pollen-grain. We have observed that the outer coat is often deposited as a very thick layer inside the special parent cell, and that, when the latter dissolves, the outer coat of the pollen-grain is also in a softened condition, and becomes stretched by the expanding inner coat, finally forming a comparatively thin layer on the ripe grain (*e. g.* in *Tradescantia*). The mode of origin of the markings, like those on SPORES and on the cuticle of *Helleborus* &c. (see EPIDERMIS), is altogether unknown; probably all the cases are referable to one cause.

It has been mentioned that the mature pollen-grain exhibits pores or slits. We believe they should rather be regarded as *thinner* places in the outer membrane. Their number and position varies much, as will be indicated presently on referring to some of the principal types of form of pollen. The slit-like markings are generally accompanied by a peculiar shrinking of the pollen when dry, the coat collapsing at the thin places, so that grains of this kind appear oval or angular, not clearly exhibiting the slits (which then become *furrows*); but they swell out and display the latter clearly when placed in water or dilute acids (Pl. 40. figs. 18 & 20). When the so-called pores exist, they are either like simple pores (Pl. 32. fig. 10), or they may be provided with little disk-like pieces or lids, which fall off and leave them bare when the pollen-tube is formed (figs. 13 & 22). In all cases, however, we believe that the outer coat is extended over the whole surface, and that the slits and dots are merely thinner places; moreover, in certain cases (*Leschenaultia*, a quaternate pollen) we have seen the thickening layers of the young pollen-grain, inside the parent cell, exhibit *pits* (exactly comparable to those of ordinary pitted cells) at the places corresponding to the future pores, and, curiously enough, in some cases at least, the pits of adjacent pollen-cells corresponding, although in the mature expanded compound grains they were far separated. Sometimes the lids are found at the end of short projecting processes (Pl. 40. fig. 22). The pollen of *Œnothera* and allied genera exhibits remarkable conditions, which have been mistakenly described. The form of the grain is that of a depressed sphere with three large equidistant truncated cones projecting pretty nearly in the same plane. The outer coat is thick, except at the ends of the conical masses; and two laminæ are distinguishable (Pl. 40. fig. 14). The outer coat thins off towards the end of each process. It appears to us that the inner coat or true pollen-membrane does not extend into the processes at all, but is globular, and that a semifluid deposit occupies the space between the inner coat and the outer, in the cavity of the tubular processes. Now, supposing such a deposit to become hardened and, after circumscissile fission, pushed off as a plate by the advancing pollen-tube, instead of giving way and expanding, we should have the lid occurring in *Cucurbita Pepo* (Pl. 40. fig. 22) and other cases.

Is has been stated that the pollen is the agent of fertilization of the ovules in the Flowering plants. When scattered from the anthers, that portion of the pollen which falls upon the stigma (and frequently

other portions falling upon nectaries or secreting surfaces) swells slightly, and germinates as it were, sending out a delicate tubular process from one or more of the so-called pores or slits (Pl. 40. fig. 30), which processes (the *pollen-tubes*) insinuate themselves between the loosely packed cells of the stigma, and, continually elongating, make their way down the style and along the *conducting tissue* to the ovules. In the Coniferæ the pollen-grains fall directly upon the micropyle of the naked OVULE, and send their pollen-tubes into it. The pollen-tube is produced by the development of the inner or proper coat of the pollen into a tubular filament. When pollen-grains are placed in dilute sulphuric acid or in syrup (sometimes in water), they absorb liquid, swell, and their contents partly exude from pores &c., either to a slight extent, as a little "hernia," as it were, of the inner membrane, or in large quantity in a worm-like, irregular mass; in the latter case the coagulation of the surface often produces a pellicular coat. These exuded masses are of course distinct from the true pollen-tubes produced under natural conditions.

The fluid contents of the pollen-grains consist of a granular viscid protoplasm, with minute starch-granules and (apparently) oil-drops, making together what has been called the *fovilla*, which increases in density as the pollen ripens. The starch-granules exhibit molecular motion in the pollen-tube, and still more clearly when they escape by rupture. The granular contents of the pollen-cell, which are always rendered opaque by the action of water, are gradually transferred to the pollen-tube as it elongates.

Connected with this point is the peculiarity exhibited by the pollen of the Coniferæ. In the Abietineæ the form of the granules is very peculiar—elongated, curved, and with bulging ends; and, according to Schacht, a distinct internal cell exists, attached at one side in the cavity of the ordinary pollen-cell, this internal cell dividing and growing out as the pollen-tube when the pollen-grain comes upon the ovule. The pollen of the Cupressineæ is spheroidal; but free cellules appear to be formed in the pollen-tubes during the fertilization. These conditions, which are not yet satisfactorily cleared up, indicate a relation to the spermatozoid-producing spores of the Marsileaceæ, &c., analogous to that between the Gymnospermous ovules and the ovule-spores of those Cryptogamic families.

It has been imagined that the form and structure of the pollen-grains might have some relation to the general structure of the plants, and might serve as an indication of systematic position and affinities. But there appears to be no definite relation; very varied pollen occurs within the limits of the same family, and very similar pollen-grains in families widely distant. There appears, however, to be a certain relation within the limits of *genera*. It may be perhaps generally stated that the Monocotyledons have frequently one pore or furrow; the Grasses often three pores, as is the case with many Dicotyledons, many of which have more, while a large number of the families of the latter division exhibit both pores and slits. As microscopic objects, it is most convenient to class the forms artificially, or according to structure; and we give a brief list of the principal varieties arranged under this point of view.

The pollen-grains of *Zostera*, *Zanichellia*, and other submerged aquatic plants, have no cuticle or outer coat; all other known forms possess one or more outer layers.

A. Outer coat without furrows or pores.

- *a.* Outer coat granular: *Strelitzia Reginæ*, *Calla palustris*, *Crocus sativus*, &c., *Asarum europæum*, *Laurus nobilis*, &c., many Euphorbiaceæ.
- *b.* Outer coat with papillæ: *Canna indica*.
- *c.* Outer coat with cell-like reticulations: *Ruellia formosa* (Pl. 40. fig. 23), *R. strepens*, *Tribulus terrestris*.

In *Periploca græca* (Pl. 40. fig. 15) and *Apocynum venetum* (fig. 7) grains of this kind are connected in fours in one plane; in some *Luzulæ* tetrahedrally.

B. Outer coat presenting longitudinal furrows (or folds).

* One furrow (the form of most Monocotyledons).

- *a.* Outer coat finely granular: common in Monocotyledons; among the Dicotyledons, in *Myrica cerifera*, *Magnolia grandiflora*, *Liriodendron tulipiferum*, &c.
- *b.* Outer coat granular, spiny: *Nymphæa alba*.
- *c.* Outer coat with cell-like reticulations: *Hemerocallis fulva*, and other Monocotyledons.

d. Outer coat with irregular reticulations: *Alstrœmeria Curtisiana.*

Among the Orchideæ are found quaternate grains belonging to this group.

** Outer coat with two furrows: a rare form, occurring in species of *Pontederia* and *Amaryllis*, *Tamus communis* and *elephantipes*, *Tigridia pavonia*, *Calycanthus floridus*, &c.

*** Outer coat with three longitudinal furrows.

a. Outer coat granular. One of the commonest forms: *Quercus Robur*, *Viola odorata* (Pl. 40. fig. 6).

b. Outer coat with short spines: *Cactus flagelliformis*, *Viscum album.*

c. Outer coat with cell-like reticulations: *Statice* (Pl. 40. fig. 29), various Cruciferæ.

**** Outer coat with more than three furrows.

a. Four: very rare as normal, *Houstonia cærulea*, *Cedrela odorata*; occasionally occurring where three is the normal number, as in *Solanum tuberosum.*

b. Six: some of the Labiatæ and Passifloreæ (Pl. 40. fig. 20), *Ephedra distachya*, *Heliotropium grandiflorum.*

c. A large number of furrows: many Rubiaceæ, e. g. *Sherardia arvensis* (Pl. 40. fig. 18).

The pollen of the Pines is related to this group, also that of *Nymphæa Lotus*, *Victoria regia*, and other plants, where the furrows or thin places occupy the greater part of the wall, and the outer coat forms only segmental pieces. In *Thunbergia alata* (Pl. 40. fig. 24 *a*) a remarkable appearance arises from the furrows running in a curved or spiral direction.

C. Outer coat with pores.

* A single pore: Grasses, Sedges, *Typha angustifolia*, *Sparganium ramosum.*

** Two pores: *Colchicum*, and a few other Monocotyledons; also *Broussonetia.*

*** Three pores.

a. Outer coat granular: Dipsaceæ, Urticaceæ, Onagraceæ [here the pores form projecting processes (Pl. 40. fig. 14); and in *Morinda persica* this is still more the case]; *Cucumis sativus.*

b. Outer coat with cell-like reticulations: many Passifloreæ—with large lids, *P. cærulea* (Pl. 40. fig. 13), *alata*, &c.

**** Four pores.

a. Pores on the equator: *Pistacia terebinthus*, *Campanula rotundifolia*, &c.

b. Pores not equatorial: *Passiflora kermesina*, *Impatiens Balsamina* (Pl. 40. fig. 21) (*Noli-me-tangere*).

***** More than four pores.

† Distributed regularly.

a. On the equator: *Alnus glutinosa*, *Ulmus campestris*, *Collomia linearis*, *Campanula Speculum.*

b. All over the grains: *Basella alba* (Pl. 40. fig. 19).

†† Scattered irregularly.

a. Outer coat slightly granular: many Nyctagineæ, Convolvulaceæ, Chenopodiaceæ, Alsineæ, *Alisma Plantago* (Pl. 40. fig. 10), *Plantago lanceolata*, *Ribes nigrum*, *Cactus Opuntia*, &c.

b. Outer coat granular and spiny: *Cucurbita Pepo* (with lids, Pl. 40. fig. 22), Malvaceæ (fig. 26).

c. Outer coat with cell-like reticulations: *Polygonum amphibium*, *persicaria*, *Cobæa scandens.*

Compound porous forms occur in some of the Onagraceæ, and in *Drimys Winteri*, where four grains are conjoined tetrahedrally. In the Mimoseæ groups of eight or sixteen (Pl. 40. fig. 25) occur in various forms. In *Leschenaultia formosa* the grains are quaternate, lying in one plane.

D. Outer coat with both furrows and pores.

* Grains rounded or depressed, with three depressions, each with a pore: most Dipsaceæ and Geraniaceæ (sometimes only two occur, Pl. 40. fig. 22).

** Three furrows and three pores.

a. Outer coat granular: a very common form among Dicotyledons.

b. Outer coat spiny: most Compositæ.

c. Outer coat with cell-like reticulations; rare: *Syringa vulgaris*, *Ligustrum vulgare*, *Grewia occidentalis*, and other species.

*** Outer coat with more than three furrows, each with a pore. Sometimes abnormally, instead of three, but normally in most of the Boraginaceæ and Polygalaceæ.

**** Six to nine furrows, three containing a pore: Lythraceæ, Melastomaceæ, Combretaceæ.

***** Three or four furrows, with six or eight papillæ: *Neurada procumbens, &c.*

****** Three furrows and three papillæ not in the furrows: *Carolinea campestris, &c.*

Starch-corpuscles exist in the fovilla of some pollen-grains in the form of very small grains which are stained blue by iodine.

Related compound forms occur in the Ericaceæ and Epacridaceæ, where the grains are tetrahedrally arranged (Pl. 40. fig. 17). Other aberrant forms occur in which the single grains are cubic or dodecahedral; and in the Cichoraceæ polyhedral forms of complicated character are common (figs. 16, 27, 28).

Mature pollen-grains should be observed dry (as opaque and transparent objects), and in water or glycerine; in some cases, in oil; treatment with acids is also useful in making out structure. In observing the development of pollen, it is necessary to wet the object with a solution of sugar or gum; otherwise the appearances are altogether changed through endosmotic action.

Bibl. Nägeli, *Entwick. des Pollens*, 1842, and on Cell-formation, *Ray Society*, 1846, 1847; Hofmeister, *Bot. Zeit.* vi. 1848; Gieswald, *Linnæa*, xxv. 81; Schacht (Coniferæ), *Beitrag z. Bot.* 1854; Saccardo, *Nuovo Giorn. Bot.* 1872; Hassall, *An. N. H.* 1841 & 1842 (pls.); Smith, *M. M. Jn.* xvii. 9 (figs.); Edgeworth, *Pollen*, 1877 (446 figs.), & *M. M. Jn.* xviii. 190; *Qu. M. Jn.* 1880, xx. 19; Warming, *Hanstein's Bot. Abh.* 1873.

POLYAC'TIS.—Separated from *Botrytis* on account of the dark, quasi-carbonized flocci.

POLYARTHRA, Ehr.—A genus of Rotatoria, of the family Hydatinæa.

Char. Eye single, cervical; foot absent; body with six cirrhi or fins on each side. Jaws each with a single tooth.

P. platyptera (Pl. 44. fig. 19). Body ovato-subquadrate, fins ensiform serrate; freshwater; length 1-190″.

P. trigla. Fins setaceous; freshwater length 1-190″.

Bibl. Ehrenberg, *Infus.* p. 440.

POLYCLI'NUM, Sav.—A genus of Tunicate Mollusca, of the family Botryllidæ (p. 115).

P. aurantium. Consists of little rounded orange masses, fixed to rocks by a short and thick peduncle.

Bibl. Forbes and Hanley, *Br. Moll.* i. 14.

POLYCOC'CUM, Sant.—A genus of Micro-lichens, parasitic on the prothallus of *Stereocaulon condensatum.*

Char. Spores eight, small, bilocular, brown.

Bibl. Lindsay, *Qu. Mic. Jn.* 1869, 343.

POLYCOC'CUS, Kütz.—Probably belongs to *Microcystis* (Rab., *Alg.* ii. 55).

POLYCO'PE, Sars.—A bivalved Entomostracon of the Cladocopa group. Upper and lower antennæ both natatory and setiferous; two pairs of posterior limbs, the first natatory, the second branchial; no eyes; no heart; intestine imperforate. Valves circular, thin, smooth, or ornamented. Marine; recent and fossil.

Bibl. Brady, *Linn. Tr.* xxvi. 470.

POLYCYS'TINA, Ehr.—A family of Radiolarian Rhizopoda.

The animal bodies are contained in shells of various forms (Pl. 39. figs. 23–31). These are rounded, conical, oval, radiate, star-shaped &c., often furnished with spines and other processes, and sometimes constricted so as to give them a jointed appearance. The shells are siliceous, everywhere perforated by coarse, rounded or angular foramina; and at one end, sometimes at both, is a larger aperture. The animal matter is olive-brown or yellowish. The Polycystina have been found on nearly every ocean-bottom. Ehrenberg found them at Cuxhaven, and in the Antarctic seas; Bailey in the depths of the Atlantic; Müller in the Mediterranean, and Häckel in the Adriatic; Wallich in the Indian Ocean; and Wyville Thomson, Carpenter, and Gwyn Jeffreys in the deep-sea soundings of the North Atlantic. The siliceous skeletons or shells accumulated in thick deposits during the last geological periods; and myriads of these exquisite microscopic forms may be obtained from many strata in Sicily, Greece, Oran, Bermuda, Richmond, Virginia, and Barbadoes. They are rare in the Chalk.

Bibl. Ehr. *Monatsb. Berl. Ak.* 1846,

1850; *Microg.* 1854; Müller, *Thalass. & Polycyst., Abh. Ak. Wiss. Berlin*, 1858; Haeckel, *Radiolarien*, 1862; Furlong, *Qu. Mic. Jn.* i. 1861–64; Claparède et Lachmann, *Inf.* 434; Wallich, *Tr. Mic. Soc.* n. s. xiii. 75; Thomson, *Deep Sea*, 98.

POLYCYS'TIS, Kütz.—See CLATHROCYSTIS. Is a *Microcystis*.

POLYCYS'TIS, Léveillé (*Urocystis*, Hallier).—A genus of Ustilaginei (Hypodermous Fungi), including several of the old species of *Uredo*; *P. colchici*, *P. parallela*, and *P. violæ* are British. See USTILAGINEI.

POLYE'DRIUM, Näg.—A genus of Unicellular Algæ.

Char. Cells single, 3–4–8-angular, the angles more or less produced. Several species, in freshwater pools. *P. longispinum* (Pl. 3. fig. 13).

BIBL. Rabenh. *Alg.* iii. 61; Archer, *Qu. Mic. Jn.* 1871, 96.

POLYEM'BRYONY.—This term is applied to a phenomenon occurring sometimes regularly, sometimes abnormally in the development of the ovules of Flowering Plants. In the Angiospermous plants it is usual to find several germinal masses in the unfertilized embryo-sac (see OVULE); but ordinarily only one of these becomes impregnated and developed. Occasionally, however, more than one commences the course of development into the embryo, as in the Orchidaceæ, and more especially in the genus *Citrus*: in most cases all but one become subsequently obliterated; but in the orange this is not the case, and ripe seeds are met with containing more than one embryo. We have met with them in other cases.

Another kind of polyembryony occurs in the Santalaceæ. *Viscum* has two or three embryo-sacs; these may all have their germinal masses fertilized, and the development of the embryos may go on to a certain point, until one takes the lead and the others disappear.

In the Gymnospermia (Coniferæ and Cycadaceæ), as described in the article OVULE, there may be one or more (*Taxus*) primary embryo-sacs, in which are produced several *corpuscula*, with secondary embryo-sacs; further, the germinal masses of these, after fertilization, produce suspensors, which branch at their lower ends, and each produces four rudimentary embryos, all but one of them vanishing during the ripening of the seeds. Our space only admits of a brief notice of these interesting phenomena, on which much interesting information will be found in the works referred to below.

BIBL. Meyen, *On Impregnation and Polyembryony, Taylor's Sc. Mem.* iii. 1; Brown, *Ann. N. H.* xiii. 368; Mirbel and Spach, *Ann. Sc. Nat.* 2. xx. 257; Crüger, *Bot. Zeit.* ix. 57; Gelesnoff, *Ann. Sc. Nat.* 3. xiv. 189, and the works of Hofmeister cited under OVULE.

POLYGAS'TRICA.—According to Ehrenberg's system, the Infusoria were subdivided into the Polygastrica and the Rotatoria. The so-called Polygastrica now correspond to the Infusoria; the Rotatoria forming a distinct class.

POLYI'DES, Ag.—A genus of Cryptonemiaceæ (Florideous Algæ), containing one British species, *P. rotundus* (Pl. 4. fig. 3), having a branched frond 4 to 6″ high, consisting of repeatedly dichotomous, purplish-brown, solid fibres, about 1-20″ in diameter. The fibres present a central layer of longitudinally arranged filamentous cells, and a cortical layer of perpendicular, dichotomous filaments, formed of elliptical cells internally, terminating at the surface in minute moniliform rows. The fructification consists of:—1. *favellæ* bearing spores, contained in superficial wart-like bodies, composed of colourless articulate filaments; 2. tetrahedrally divided *tetraspores*, embedded in the peripheral filaments of the cortical layer of the frond. Antheridia have not yet been observed.

BIBL. Harvey, *Mar. Alg.* 146; *Phyc. Brit.* pl. 95; Greville, *Alg. Brit.* pl. 11.

POLYKRIKOS, Butschli.—A genus of Holotrichous Infusoria. *P. Schwartzii*, marine. (Kent, *Inf.* 508.)

POLYMORPHI'NA, D'Orb.—A genus of Hyaline Foraminifera. Inequilateral, oblong or elongate, globose or compressed (Pl. 23. fig. 40, *P. communis*; fig. 42, *P. oblonga*; fig. 43, *P. compressa*); chambers often numerous, alternate in two rows, slightly embracing, but always more so on one side than the other; orifice round, at the summit of the last chambers, radiate. Sometimes the later chambers have branching, tubular apertures (*P. Orbignii*, Pl. 23. fig. 41).

Many species in all seas; fossil from the Trias upwards.

BIBL. Williamson, *Rec. For.* 70; Carpenter, *For.* 166; Brady, Parker, and Jones, *Linn. Tr.* xxvii. 197.

POLYNE'MA.—A genus of Hymenopterous insects. The perfect insect is aquatic

in its habits, swimming by means of its wings. It lays its eggs inside those of Dragonflies.

Bibl. Lubbock, *Linn. Tr.* 1863; *Metam. Insect.* 37.

POLYŒ'CA, Kt.—A genus of Choanoflagellate Infusoria. Like *Salpingœca*, but the carapaces united into a branched zoary. *P. dichotoma*, marine. (Kent, *Inf.* 360.)

POLYOM'MATUS, Latr.—A genus of Lepidopterous Insects, of the family Lycænidæ.

Char. Antennæ terminated by a contracted knob; tarsal claws minute; wings not tailed.

The (thirteen) species are small butterflies, the upper surface of the wings of a beautiful blue colour, the under side grey or brownish, and with numerous eye-like spots.

The scales upon the under surface of the wings of *P. argiolus* and *P. argus* have been proposed as test-objects. They are of two kinds—one resembling in structure the ordinary scales of insects, the other of a battledore form (Pl. 34. figs. 20 & 21). See Scales of Insects and Test-objects.

The species are figured in Westwood's *British Butterflies*.

POLYPHE'MUS, Müll.—A genus of Cladocerous Entomostraca, family Polyphemidæ.

Char. Head distinct from the body; abdomen long, slender, and projecting externally from the shell.

P. pediculus (Pl. 19. fig. 29). The only species. Freshwater.

Bibl. Baird, *Brit. Entomostr.* 111; *An. N. H.* 1877, xix. 119; Claus, *Polyph.* 1877.

POLYPHRAG'MA, Reuss.—A large stichostegian Arenaceous *Lituola*, with numerous short chambers and cribrate septa. Fossil; Cretaceous. Saxony and Bohemia.

Bibl. Von Reuss, *Geinitz's Elbthalgebirge*, I. iv. 139.

POLYPI.—A group of Zoophytes, comprising the Actinaria and Hydroida. Body rounded or cylindrical, with a distinct mouth, surrounded by retractile non-ciliated tentacles or radiating lobes; individuals usually aggregate; gemmiparous and oviparous.

The polypes are usually enveloped in an external (Pl. 41. figs. 4 *b*, 12, & 14), or supported by an internal axial skeleton (Pl. 41. fig. 6), called the polypidom. This is either horny, leathery, or calcareous. Most polypes are united into smaller or larger groups by the polypidom, which often possesses an elegant plant-like form (Pl. 41. fig. 15). The tubular or cup-shaped processes or cavities in which the body of the individual polypes is contained, form the polype-cells or capsules; they are sometimes furnished with a kind of lid.

The structure of the calcareous polypidoms has not been satisfactorily determined. They are usually traversed by vascular canals, and appear in some cases at least to consist of aggregated and fused spicula.

The polypes are rarely free, or capable of fixing themselves by a disk at the base of the body, as in *Hydra*, being usually fixed at the bottom of the polype-cells, the polypidoms being attached by a rooting base to some foreign body. Imbedded in the outer parts of the soft substance of the body, especially the tentacles, are stinging organs (Pl. 41. fig. 22), resembling in general those of the Acalephæ.

In many, distinct muscles are present; but the fibres are not transversely striated, although frequently exhibiting wrinkles. In some polypes, the substance of the body consists entirely of sarcodic substance. In many, both the integument and the substance of the body contain calcareous spicula (Pl. 41. figs. 7, 27, & 28).

The alimentary apparatus consists of a mouth and a simple gastric sac, the food being admitted and the undigested portion rejected from the single aperture, except in one genus, where the anus is separate. The oral orifice is usually surrounded by a ring of contractile arms and tentacles, which are hollow internally, and communicate with the cavity of the abdomen; sometimes the tentacles are distributed over the surface of the body.

The simple gastric cavity is usually separated from the cavity of the body; whereby a larger or smaller abdominal cavity is formed, which is usually prolonged into the hollow arms, and in many polypes living in colonies passes into the canals traversing the interior of the polypidom, so that the abdominal cavities of the individual polypes are all brought into connection by these canals. Sometimes longitudinal partitions run like a mesentery from the outer to the inner surface of the abdominal walls, thus dividing the abdominal cavity into chambers. The bottom of the gastric cavity is provided with one or more spontaneously closeable openings,

by which it communicates with the abdominal cavity. The gastric cavity is covered with ciliated epithelium, which is continued through the gastric apertures into the abdominal cavity, and here not only covers the outer surface of the stomach and the septa, but also the inner surface of the abdominal walls, the cavities of the arms, and the canals of the polypidom.

The walls of the stomach are variously coloured, white, yellow, or brown, from the presence of aggregations of pigment-cells (liver cells), which probably perform the function of a liver, as there is no glandular appendage corresponding to a liver present.

A peculiar circulation takes place in most polypes, by the to-and-fro motion of a nearly transparent liquid containing minute colourless corpuscles, in the abdominal cavity. In the colonial polypes, this circulation continues through the canals which traverse the polypidoms, from one abdominal cavity to the other.

The propagation of the polypes takes place: by spontaneous division, which is mostly longitudinal and rare; the formation of gemmæ or buds, which is very common, the individuals either separating or remaining attached; and by the formation of ova. Most of the gemmæ become developed into ordinary polype-cells, and so produce the growth of the compound organism. But in many polypes, some of them grow into large cells, of different form from the common polype-cells, constituting the ovarian vesicles, or capsules (Pl. 41. figs. 14 *b* and 16 *b*). In these, the gemmæ, which are developed within them, and which are often called ova, gradually become bell- or disk-shaped, and assume the form of *Acalephæ*; and on escaping from the vesicles, swim about freely, subsequently either becoming directly developed into new polypes, or acquiring sexual organs and producing ova.

In other (simple) polypes, distinct spermatic and ovi-sacs occur in the parent animals; either together in the same animal, and external (*Hydra*), or separately in different individuals and internal (*Actinia*, &c.).

The ovum-embryo of the polypes is usually more or less elongate-oval, coated with cilia, and moves about on its long axis like an infusorium. After a short time, it fixes itself to some object, the cilia disappear, and the tentacles of the polype are protruded; as these polypes increase by gemmation, new colonies are formed.

The formation of coral reefs and islands by the skeletons of polypes is well known.

The new names of the Polype-structures will be found in the Art. HYDROIDA, and Hincks's 'Zoophytes.'

POLYPODIA'CEÆ. — An order of Ferns, divided into 13 families by the characters of the sporanges.

Synopsis of the Families.

* *Sori with an indusium* (*except* Alsophila).

CYATHEÆ. Sporanges numerous, sori on a raised receptacle, with a somewhat oblique annulus.

DICKSONIEÆ. Sori globose, on the back or apex of a vein; indusium subglobose, free, at length bursting irregularly, more frequently cup-shaped, entire or with 2 lips.

HYMENOPHYLLEÆ. Sori terminal or marginal from the apex of a vein; receptacle elongate, often filiform, and more or less exserted, clothed with sessile orbicular subpeltate compressed capsules, with a transverse ring opening vertically.

DAVALLIEÆ. Sori rounded, marginal or submarginal, covered by a reniform or rounded scaly indusium open at the apex, fastened broadly at the base, and open at the sides.

LINDSAYEÆ. Sori in a line at or near the end of the frond, inner valve of indusium membranous, the outer formed of the margin of the frond.

PTERIDEÆ. Sori marginal, linear or oblong; indusium of the same shape as the sorus, formed of an altered and reflexed portion of the frond, opening inwardly.

BLECHNEÆ. Sori linear or oblong, dorsal, parallel with the midrib and edge of the segments, not close to the latter; indusium shaped like the sorus, superior, opening towards the midrib.

ASPLENIEÆ. Sori attached to the veins, oblique or subparallel to the midrib, linear or oblong. Indusium shaped like the sorus, when single, opening towards the midrib, sometimes double.

SCOLOPENDRIEÆ. Sori as in Aspleniеæ, but the indusia arranged in pairs and open towards each other.

ASPIDIEÆ. Sori dorsal, subglobose, rarely elliptical; indusium superior, shaped like the sorus, fixed either by the centre or a sinus.

** *Indusium absent.*

POLYPODIEÆ. Sori on the back of the lobes, round or rarely oblong, not more than twice as long as broad.

GRAMMITIDEÆ. Sori on the back of the lobes, more than twice as long as broad, usually linear.

ACROSTICHEÆ. Sori spread over the under surface or rarely both surfaces of the frond, not confined to the veins.

POLYPODIE'Æ.—A family of Polypodiaceous Ferns; contains the single genus *Polypodium*.

POLYPO'DIUM, Linn.—A genus of Ferns with naked sori, of which there are several indigenous representatives, *P. vulgare*, the Oak-Fern, being one of our commonest species. Exceedingly well adapted for examination of the structure of the sori and sporanges in this family.

POLYPOR'EI.—A family of Hymenomycetous Fungi, characterized by bearing basidiospores lining tubes, pores, or pits, on the underside of a stalked or sessile *pileus*, or fleshy cap or disk. The basidiospores are seen by horizontal sections from the undersurface of the pileus. (See BASIDIOSPORES and HYMENOMYCETES.)

BIBL. Berk. *Fruct. of Fungi*, *Ann. N. H.* i. 81; Léveillé, *Ann. Sc. N.* 2. viii. 324.

POLYSAC'CUM, D. Cd.—A genus of Trichogastres (Gasteromycetous Fungi), having a common peridium filled with peridiola; the spores mixed with threads. One species only occurs, and very rarely in this country. Abroad they grow on exposed sand. One of the species has been used in dyeing. *P. crassipes*, p. 349, fig. 269.

BIBL. Fr. *Syst. Myc.* iii. 54; Berk. *Outl.* 304; Sow. t. 425; Cooke, *Handb.* 375.

POLYSEL'MIS, Duj.—A doubtful genus of Infusoria, of the family Euglenia.

Char. Oblong or variable in form, with several anterior flagelliform filaments, and a single red eye-spot.

Probably the zoospore of a Confervoid Alga.

P. viridis (Pl. 31. fig. 68) resembles a *Euglena* of an oblong form with the ends rounded; one of the filaments is longer than the three or four others which surround its base. Freshwater; length 1-650".

BIBL. Dujardin, *Infus.* 370.

POLYSIPHO'NIA, Grev.—An extensive genus of Rhodomeleæ (Florideous Algæ) or Red sea-weeds, with cylindrical, more or less articulated fronds, the joints consisting of a circle of longitudinally arranged cells surrounding a central cell, like the wood-bundles of a young Dicotyledonous stem surrounding the pith, so that the transverse section presents the appearance of a rosette. The number of peripheral cells varies among the 300 different species of this genus, from four to twenty-five; the British forms mostly have four and six. In some of the species a kind of rind is formed subsequently, by a growth from the base of the joints analogous to that which occurs in BATRACHOSPERMUM and CALLITHAMNION. The fructification consists of:—1. *ceramidia*, urn-shaped or ovate, attached to the sides of branches, containing numerous pear-shaped spores at the base; 2. *tetraspores* on distinct plants, formed in the swollen central cell of distorted branches (fig. 598); these are gonidia and develop a thallus; and 3. *antheridia*, elongated whitish sacs, collected in great numbers at the summits of the branches, accompanied by a dichotomous hair, and sometimes prolonged into a hair-like process at the summit. Nägeli describes the spermatozoids as consisting of a spiral filament. Thuret states that they are merely hyaline globules, about 1-5000" in diameter, without active motion. The British species are placed in two subgenera—*Oligosiphonia*, where there are but four or rarely five peripheral cells, and *Polysiphonia*, where there are six or more. Twenty-six species are described, many of which are common. (*P. fastigiata*, Pl. 4. fig. 20.)

Fig. 598.

Polysiphonia nigrescens.

Distorted ramuli containing imbedded tetraspores.

Magn. 50 diams.

BIBL. Harvey, *Mar. Alg.* 82, pl. 12 A; Thuret, *Ann. Sc. N.* 3. xvi. 16, pl. 6; Nägeli, *Zeitsch. wiss. Bot.* 1846, 207, pls. 6 & 7; Henfrey-Masters, *Bot.* 433.

POLYS'TICHUM = *Aspidium* pt.

POLYSTOMEL'LA, Lamk.—A genus of Hyaline Foraminifera. Shell free, regular, equilateral, biconvex, sometimes compressed, often dorsally keeled; spire embracing; chambers with a single cavity, straight or arched, meeting at the umbilicus and furnished with transverse pits between the

sutures or over them. Orifices numerous, arranged along the margin of, or forming a triangle at, the upper part of the last chamber. *Polystomella* passes into *Nonionina*, through *P. striato-punctata* (Pl. 24. f. 19), common in cold seas.

P. crispa (Pl. 24. fig. 20) is common in temperate seas. *P. craticulata* is of tropical growth. *P. macella* (*Faujasina*) is unsymmetrical and starved. Many fossil forms.

Bibl. D'Orbigny, *For. Vien.* 121; Williamson, *Foram.* 39; Morris, *Br. Fossils*, 40; Parker & Jones, *Ann. N. H.* 3. v. 103; Carpenter, *For.* 276.

POLYTHALA'MIA. See Foraminifera.

POLYTOMA, Ehr.—A genus of Flagellate Infusoria, family Monadina (Hydromorina).

P. uvella (Pl. 31. fig. 69, undergoing division), the only species, is oblong or oval, obtuse at the ends, colourless, furnished with two flagelliform filaments; it has no carapace. Fresh or decomposing water; length 1-2200 to 1-960″; size of body when the division is nearly complete, 1-400″.

As it increases in size it assumes a wrinkled or mulberry appearance, and this indicates the approaching division into many sections, whence the name.

Bibl. Ehr. *Inf.* 24; Schneider, *Ann. N. H.* 1854, xiv. 321; Pritchard, *Inf.* 136 & 504; Kent, *Inf.* 301.

POLYTREMA, Blainville.—A protean parasitic Foraminifer of the Rotaline family; scale-like, globular, or arborescent, with cancellated structure. *P. miniaceum* is widely distributed in the Mediterranean and other warm seas.

Bibl. Carpenter, *For.* 235; Schultze, *Wiegm. Arch.* 1863, 81; *Ann. N. H.* 3. xii. 409; Carter, *ibid.* 4. xvii. 185; 5. v. 440.

POLYTRICHA'CEÆ. — A tribe of Mnioideæ (operculate Mosses of usually Acrocarpous habit).

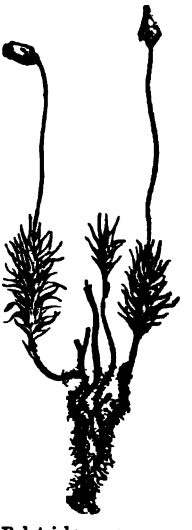
Genera.

Catharinea. Calyptra narrowly hood-shaped, subscabrous at the apex, rather hairy within. Peristome simple, composed of thirty-two teeth, arising from a narrow, cellular basilar membrane, ligulate, membranous, white, with many percurrent, reddish, inarticulate filaments, somewhat incurved, scarcely hygroscopic, firm. Columella dilated at the apex into a drum-like epiphragm. Capsule equal. Inflorescence monœcious or dicœcious.

Polytrichum. Calyptra dimidiate, but appearing campanulate on account of a quantity of very close hairs descending from it as a long villous coat; otherwise resembling the preceding genus.

POLYTRICHUM, Dill. — A genus of Polytrichaceous Mosses, variously defined by different authors. In the British Flora, it includes the forms separated in this work under Catharinea, which in the 'Bryologia Britannica' are divided between *Atrichum* and *Oligotrichum*. The species of *Polytrichum* comprised in our definition are distributed in the same work under *Pogonatum* (those with a round capsule and thirty-two teeth) and *Polytrichum* proper (those with a square or prismatic apophysate capsule (fig. 600), and usually twice as many teeth). *P. commune* is one of our finest Mosses, common on heaths, moors, and mountain tracks, varying somewhat under the different physical conditions. The stems are from 6″ to 1′ long, and the fruit-stalks 2 or 3″. The stems are almost of woody texture, the leaves large and firm. The calyptra is densely covered with hairs. Wilson remarks that the true structure of the sporange and columella of Mosses may be most easily learned from the study of this genus. The columella is seen (figs. 601, 603), to be separated from the spores by an inner layer of the sporangial membrane. The diaphragm attached to the apices of the teeth of the peristome is the dilated apex of the columella (fig. 603).

Fig. 599.



Polytrichum commune.
Plants in fruit.
One half natural size.

The peristome (fig. 602) is composed of ligulate obtuse teeth, connected by a membrane at the base, continuous with the inner layer of the wall of the capsule. These plants are also exceedingly well adapted for the examination of the male inflorescence and spermatozoids. They are all dicœcious; and the male plants (fig. 604) are readily distinguishable by the cup-shaped inflores-

cence, composed of scale-like leaves and paraphyses surrounding a number of subulate sacs constituting the *antheridia*. The male flowers of *P. commune*, *juniperinum*, &c.

Fig. 600.

Fig. 601.

Polytrichum commune.

Capsule with operculum. Magnified 10 diameters.

Section of young capsule showing the plaited sporangial membrane.

are found everywhere on heaths in spring. The antheridia may be readily extracted under a simple lens, and, when placed in water

Fig. 602.

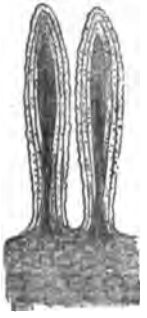


Fig. 603.

Polytrichum commune.

Fragment of peristome. Magn. 100 diams.

Columella with section of the apophysis. Magn. 25 diams.

under the compound microscope, soon (if ripe) burst at the summit and discharge the spermatozoids; these usually escape still enclosed in their parent cells, which when first discharged cohere in a gelatinous mass; but the ciliated spermatozoids (Pl. 40. fig. 33) escape and swim actively in the water. They require at least an eighth object-glass for examination; and the cilia are seen most clearly after drying the object, or treating it with tincture of iodine.

Fig. 604.

Fig. 605.

Polytrichum commune.

Male inflorescence. One half nat. size.

Innovation from male inflorescence. Magn. 5 diams.

BIBL. Wilson, *Bryol. Brit.* p. 205 *et seq.*; Thuret, *Ann. Sc. Nat.* 3. xvi. 26, pl. 14.

POLYZO'A or BRYOZOA.—A class of Animals, belonging to the subkingdom Mollusca.

Char. Polypiform, aggregate; individual bodies microscopic, contained in horny or calcareous cells, often connected by tubular stems, forming a usually branched zoary; mouth surrounded by long, ciliated, uncontractile tentacles; mouth and anus separate, but near each other. Marine and freshwater.

They are found everywhere on the seashore, either rooted to, or forming a crust upon submerged rocks, stones, shells, &c. The individual is called a polypide; and the aggregate or colony constitutes a cœnœcium or polyzoarium; it is usually of a whitish or brownish colour, of a horny or calcareous texture, and consists either of cells or cups simply aggregated (Pl. 41. figs. 17, 20), or connected by tubular stems, and often arranged in elegant plant-like forms (Pl. 41. fig. 5 *a*). The stems are divided into compartments by perforated septa (Pl. 41. fig. 5 *f*), through which thread-like filaments of the sarcode pass.

The cells are of various forms, mentioned under the genera, and they are often furnished with bristles or spines. At the orifice of each cell the tentacles and more or less of the body of the animals are protruded. In the marine or Infundibulate order, the structure of the cell-mouth is used as a character,—those in which it is terminal and simple (Pl. 41. fig. 30) forming the Cyclostomata; and those in which it is subterminal, curved, and furnished with a movable lid, the Cheilostomata (Pl. 41. fig. 5 *b*); whilst in the Ctenostomata there is a comb-like circular fringe of bristles connected by a membrane surrounding ths cell-orifice, visible when the body is partly protruded. Most are fixed; but *Cristatella* is free and locomotive, having a discoid base.

Curious appendages are found attached mostly to the cells of the polyzoaries. The first are called bird's-head processes or *avicularia* (Pl. 41. fig. 5 *b**, and fig. 26). They consist of a body (fig. 26 *d*), a hinge- or lower-jaw-like process (fig. 26 *e*), and a stalk (*f*). They are attached by the stalk to the interior of a round hollow process, projecting slightly from the surface of the polyzoary (fig. 26 *a*). The body is divided by an oblique ridge (fig. 26 *d*) on its inner surface into two chambers. The lower portion is moved up and down by an elevator and depressor muscle (fig. 26 *c*). During life the motion is constant; and it continues long after the death of the animal. These bodies appear analogous to the pedicellaria of the Echinodermata.

The second kind, called *vibracula*, consist of a hollow process (fig. 5 *d, b*), from which a vibrating filament (fig. 5 *d*) projects. The interior of the process is filled with a contractile substance which moves the filament.

The body is usually oblong or elongate. At its anterior end is a ring or disk (*lophophore*), upon which the tentacles are placed; this is perfect in the Infundibulata, but deficient at one part, or horse-shoe shaped in the Hippocrepia (Pl. 41. figs. 3 *c* & 9). The tentacles are hollow, closed at the end, uncontractile, coated externally with cilia on the sides next each other, and communicate with the cavity of the body through apertures in the disk. In most of the Hippocrepia, the tentacles are surrounded at the base by a transparent cup-like membrane (*calyx*), prolonged somewhat upon each tentacle, and mostly dentate at the margin.

Digestive System.—The mouth is situated in the middle of the tentacular disk (Pl. 41. fig. 3 *c*), and is closeable in the Hippocrepia by an epiglottis-like hollow valve (*epistome*), which is absent in the Infundibulata; at the base of this valve is an aperture which perforates the disk to open into the abdominal cavity. The mouth terminates in a pharynx (Pl. 41. fig. 5 *e, f*), and œsophagus (fig. 18, *b, d*), often of considerable length, which is sometimes succeeded by a strongly muscular gizzard. Next comes the stomach (figs. 5 *e, b*, 18 *f*), often very capacious, and with an appendix (fig. 18 *e*), and finally the intestine (fig. 18 *g*), which terminates outside, but close to the disk (fig. 5 *e, c*). Thus the alimentary canal is bent upon itself, the two orifices being very near each other.

The alimentary canal consists of three coats—an inner rugose, composed of cells with brownish contents, and representing a liver; a middle, composed of colourless nucleated cells; and an outer, thin, cellular coat, probably containing muscular fibres. The mouth and more or less of the upper portion of the alimentary canal are ciliated.

The walls of the cavity of the abdomen, the interior of the disk and of the tentacles all communicate, and are filled with a clear liquid, in which irregular particles float, and in which a constant rotatory motion exists, produced partly by muscular action, and partly by cilia. This liquid corresponds to a chylaqueous fluid, and performs the chyliferous, sanguiferous, and respiratory functions; for there are no distinct respiratory organs, nor blood-vessels.

The muscular system is well developed, the fibres being transversely striated—the principal, or retractors, arising from the bottom of the cells, and being inserted into the sides of the œsophagus, so as to exert a retracting action upon the body. There are also parietal muscles, which are in the form of circular bundles running transversely round the cell; they project the polypide.

The nervous system consists of an oval ganglion placed between the oral and anal apertures, and giving off branches to the tentacles, alimentary canal, &c.; and there is stated to be a nervous connexion between all the cells of a zoarium, called the colonial system.

Reproduction.—The Polyzoa are propagated by gemmation, and by the agency of sexual organs.

Two kinds of gemmation occur. In the first, the gemmæ are developed externally from the parent cells, and usually near the

orifice, but often from the stem; these gemmæ, on attaining their full development, remain attached to the parent, thus forming the compound organism. In the second, they are formed internally, as buds upon the funiculus, which is a process passing from the testis to the stomach. Afterwards they become free within the abdominal cavity, from which they escape at an orifice near the disk, according to Beneden, although this is denied by Allman. The latter kind, which are often called ova, have an external hard coat, exhibiting the appearance of a marginal ring, and are often of a dark colour; their development is not dependent upon impregnation, and they seem to correspond to the winter ova of the Entomostraca &c.: Allman proposes the name *statoblasts* for them. The sexual organs, which usually exist together in the same individual cell, consist of a roundish ovary, attached by a short peduncle near the orifice of the cells; whilst the testis is a rounded irregular mass attached to the funiculus. The ova, which are first set free in the abdominal cavity, are ciliated and swim freely.

Four modes of reproduction in the Polyzoa have been described, three of them taking place in an asexual way:—1. The growth of the whole colony by buds which are external; 2. The reproduction by eggs formed by internal buds of the endocyst; 3. The production of new polypides and eggs in empty cells (zoœcia), by brown bodies which are produced out of the former polypide of the cell by retrogressive metamorphosis; 4. Sexual reproduction by eggs and spermatozoa.

The Polyzoa are divided into two orders:

Order I. Hippocrepia (*Phylactolæmata*).

Tentacular disk horse-shoe shaped or bilateral; mouth with an epistome; mostly freshwater.

Order II. Infundibulata (*Gymnolæmata*).

Disk circular, or nearly so; epistome absent; mostly marine. 3 suborders:

Cyclostomata. Cells with a simple round orifice.

Cheilostomata. Orifices of cells fitted with a thin, membranous or calcareous plate; with a curved mouth, furnished with a moveable lip.

Ctenostomata. Orifices surrounded by a circle of setæ.

Bibl. Johnston, *Br. Zooph.* 253; Busk, *Mar. Polyzoa, Brit. Mus.*; Fossil, *Pal. Soc.* 1859; Farre, *Phil. Tr.* 1837; Dumortier and Beneden, *Mém. Ac. Brux.* 1850; Hancock, *Ann. N. H.* 1850, v.; Allman, *Freshw. Polyzoa, Ray Soc.*; Gosse, *Mar. Zool.* ii. 1; Müller, *Wieg. Archiv*, 1860, 311; Huxley, *Invertebr.*; Smitt, *Qu. Mic. Jn.* 1871, 155; Müller, *Reich. & D. Reymond's Archiv*, 1860; Claparède, *Sieb. & Köll. Zeit.* 1871, 137; Norman, *Qu. Mic. Jn.* 1868, 212; Hyatt, *Pr. Essex Institute, U. S. A.* 1868; Nitsche, *Sieb. & Köll. Zeit.* 1870; Barrois, *Embryol.* 1877; Hincks, *Polyzoa*, 1880.

POM'PHOLYX, Gosse.—A genus of Rotatoria, family Brachionæa. *P. complanata*; freshwater. (Gosse, *Ann. N. H.* 1851, viii. 203.)

POMPHOLYX'OPHRYS, Archer, *Hyalolampe*, Greef.—A genus of freshwater Rhizopoda.

Char. Rhizopod composed of two distinct sarcode regions, the inner a dense coloured globular sarcode mass, the other colourless, and bearing a number of separate hyaline globular structures; these are disposed in a layer around the inner globe, which latter gives off slender non-coalescing pseudopodia.

Bibl. Archer, *Qu. Mic. Jn.* 1870, p. 105.

PONTEL'LA, Lubb.—A genus of Copepodous Entomostraca. *P. Wollastoni*, Weymouth. (*Ann. N. H.* 2. xx. 406; Brady, *Cop.* i. 73.)

PONTIA, Fabr.—A genus of Lepidopterous Insects, of the family Papilionidæ.

This genus contains some of the commonest butterflies, as *P. brassicæ*, the large cabbage-butterfly; *P. rapæ*, the small cabbage-butterfly; and *P. napi*, the green-veined white butterfly.

The form and structure of certain scales existing upon the under side of the wings of the males are curious; and the markings were formerly found so difficult to render distinct, that the scales were used as test-objects.

In the male *P. brassicæ* the upper surface of the anterior wings is free from spots, whilst in the female there are two black spots in that situation. The peculiar scales are represented in Pl. 34. fig. 24; fig. 26 exhibits a portion of the wing with the ordinary scales.

In *P. rapæ* and *P. napi* the anterior wings of the males have a single spot upon the upper surface, whilst there are two upon each wing in the females. The peculiar scales bear considerable resemblance in the

two species (Pl. 34. fig. 23 *a*, scale of *P. rapæ*; fig. 23 *b*, portion of wing, showing the points of attachment of the two kinds of scales).

The scales may be separated by gently pressing the under surface of the wings against a slide.

See SCALES of INSECTS and TEST-OBJECTS.

BIBL. Westwood, *Brit. Butterflies.*

PONTOCY'PRIS, Sars.—An Ostracode, near *Argillœcia* among the *Cypridæ*, with fragile pod-like valves, higher in front than behind; no branchial appendage on the second pair of jaws; upper antennæ long and setiferous. 3 British species, rather common.

BIBL. Brady, *Linn. Tr.* xxvi. 384.

POPPY.—The seeds of Poppies (*Papaver*, L., Nat. Order Papaveraceæ) are elegant opaque objects under a low power, the testa being pitted so as to produce a reticulated surface (Pl. 39. fig. 14).

PORCELLID'IUM, Claus.—A genus of Copepoda. 4 species, among *Laminariæ*, &c. (Brady, *Copep., Ray Soc.*)

PORIFE'RA. See SPONGIDA.

POROCYC'LIA, Ehr.—A genus of Diatomaceæ closely allied to LIPAROGYRA.

BIBL. Pritchard, *Infus.* 823.

PORODIS'CUS, Grev.—A genus of Diatomaceæ, fam. Melosireæ. (Rabenht. *Alg.* i. 35; Greville, *Mic. Tr.* 1863, 63; 1865, 46.)

PORO'NIA, Fr.—A genus of Sphæriacei (Ascomycetous Fungi), consisting of a corky stroma, which is flat or hollowed out at the top, and studded with the ostiola of the perithecia. The only British species is not uncommon on horse-dung.

BIBL. Fr. *Syst. Myc.* ii. 330; Berk. *Outl.* 385; Cooke, *Handb.* 791; Tul. *Carp.* ii. 27, t. iii.

POROSPHÆ'RA, Steinm.—Small globular fossils, common in the chalk, known as *Orbitolinæ*, formerly referred to Sponges and Foraminifera, now found by Carter and Steinmann to have Hydractinian structure; calcareous, with reticular tissue and radiate tubes. (Steinmann, *Palæontographica*, 1878, xxv. 120.)

POROUS STRUCTURES OF PLANTS.—What are ordinarily called porous tissues in vegetable anatomy are described in accordance with their real nature under the head of PITTED STRUCTURES. True pores do, however, occur in the walls of vegetable cells, from secondary or ultimate changes in their character. They are seen in the cells of the leaves of *Leucobryum* and *Sphagnum* (see SPHAGNACEÆ). Other regular orifices are produced in the walls of the cells of many of the zoospore-producing Confervæ, as *Conferva*, *Cladophora*, *Enteromorpha*, &c. (see Pl. 9). The wall of the sporangial cell of *Achlya* presents analogous openings; and according to Cohn, pores are produced in the spore-cells of SPHÆROPLEA to admit the spermatozoids. The pits and the interstices between reticulated fibrous secondary deposits are often changed into true holes in old cells, but this is the result of decay of the primary membrane; it takes place very early however, at the contiguous ends of SPIRAL-fibrous and PITTED CELLS coalescing to form ducts, changing the septum formed by the adjoining ends into a kind of grating, or irregularly torn diaphragm.

PORPE'IA, Bail.—A genus of Diatomaceæ, closely allied to BIDDULPHIA. Gulf-stream.

BIBL. Pritchard, *Inf.* 350; Rabenht. *Alg.* i. 315.

POR'PHYRA, Ag.—A genus of Porphyraceæ (Florideous Algæ), with an expanded, membranous, shortly-stalked frond, composed of a single layer of cells approximated in fours, the contents purple or red. Fructification consisting of:—1. scattered sori of oval *spores*; 2. *octospores* immersed in the frond; and 3. *antheridia*, on the same or distinct plants. *P. laciniata* and *vulgaris* are common on our coasts.

BIBL. Harvey, *Mar. Alg.* 261, pl. 25 A; Thuret, *Ann. Sc. Nat.* 4. iii. 5; Janczewski, *Mém. Soc. Cherbourg*, xvii. 345.

PORPHYRA'CEÆ.—A tribe of Florideous Algæ (according to Thuret), of low organization, forming Ulvoid membranous fronds or strata of Confervoid filaments, of a purple or red colour. They are placed among the Ulvaceæ by most authors, but differ in the absence of the zoospores and the presence of tetraspores (octospores) and antheridia. They are marine,—*Porphyra* growing on rocks and stones, *Bangia* the same, or parasitic upon *Zostera*, Algæ, &c.

British Genera.

Porphyra. Frond plane, membranous, very thin, of a purple colour, with oval spores in sori, and tetraspores (square) scattered all over the frond.

Bangia. Frond filiform, tubular, composed of numerous radiating cells in transverse rows, enclosed within a continuous hyaline sheath.

PORHPY'RIDIUM = *Palmella cruenta.*

PORRI'GO. See FAVUS.

POTAMOCY'PRIS, Brady.—One of the *Cypridæ*; valves reniform, thick, right larger than left; upper antennæ with very short setæ; post-abdominal rami rudimentary. 1 British species.

BIBL. Brady, *Nat. Hist. Tr. North. & Durham*, iii. 365.

POTASH, AND ITS SALTS.

Caustic Potash.—The strength of the solution may be that of the Liq. Potassæ of the Pharmacopœia. But we prefer a stronger solution made with 1 drachm of the *potassa fusa* or stick-potash of the shops, and 1 fluid oz. of water. The solution should be allowed to settle, and the clear portion poured off into one of the test-bottles (INTR. p. xxvii).

Some remarks are made upon the action of potash in the INTR., and others under the heads of the tissues, &c. On treating organic substances with this reagent, the cystic-oxide-like crystals of the carbonate (Pl. 10. fig. 26) will frequently be formed.

Chromates of Potash.—The bichromate is used in the preparation of the chromate of lead for injection. Its crystals polarize well. The neutral chromate is also sometimes used for preparing injections. See PREPARATION.

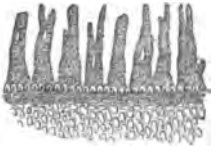
Nitrate of potash, nitre, or saltpetre.—This salt is dimorphous: it usually crystallizes in six-sided prisms with dihedral summits, or in other forms belonging to the right-rhombic prismatic system. But sometimes it assumes the form of obtuse rhombohedra, resembling those of nitrate of soda, and referable to the rhombohedric system.

The crystals exhibit very beautifully the phenomena of ANALYTIC CRYSTALS.

POTATO-FUNGUS. See BOTRYTIS.

POTTIA, Ehr.—A genus of Pottiaceous Mosses, including some of the *Gymnostoma* and *Weissiæ* of Hedwig and others. Wilson separates as *Anacalypteæ* the species with a peristome (fig. 606).

Fig. 606.



Pottia cæspitosa.
Fragment of peristome.
Magnified 50 diameters.

POTTIA'CEÆ.—A tribe of Pottioi Mosses.

Synopsis of Genera.

Pottia. Calyptra dimidiate. Peristome simple or wanting; if present, composed of lanceolate articulate teeth, simple or with a longitudinal line, rugulose and somewhat fleshy.

Trichostomum. Calyptra dimidiate. Peristome simple, sixteen teeth, each split to the base into two cilia, or irregularly and therefore into more than two, erect, stiff, and not twisted.

Barbula. Calyptra dimidiate-hood-shaped. Peristome simple, ciliiform; cilia thirty-two, solitary or approximated in pairs on a more or less exserted basilar membrane, split into two cilioles behind, very long, articulate-rugulose, twisted to the left, rarely to the right, in one or several spires, hygroscopic. Cells of the operculum and calyptra twisted in the same way.

Ceratodon. Calyptra dimidiate. Peristome simple; teeth sixteen, connate at the base into a cellular membrane, split into two long, nodosely articulated dark-coloured arms, paler on each side, densely trabeculated at the lower part. Capsule thick-skinned, shining, nodding, with a somewhat nodose collum; annulate.

Weissia. Calyptra dimidiate. Peristome simple or wanting; if present, composed of sixteen lanceolate or subulate, entire or cribrose, equidistant teeth.

POTTIOI'DEÆ.—A family of Acrocarpous operculate Mosses, but sometimes Pleurocarpous by innovating branches. Leaves of varied form, with a terete nerve; cells parenchymatous, hexagonal or squarish six-sided, looser at the base, sometimes very lax, more or less pellucid, often exceedingly transparent, large, fragile, rigid, foraminate, bearing on the upper side solitary papillæ or confluent papillæ (hence often truncate and tuberculate at the apex), placed in the middle of the cell; cells mostly full of chlorophyll, often very small and thickened. Capsule erect, rarely inclined, oval, elliptic or pear-shaped oblong, smooth or striate, the operculum mostly conical or beaked.

This family is divided into three tribes:

CALYMPERACEÆ. Basilar cells of the leaves rigid, hyaline, often very brittle, more or less ample, empty, distinctly foraminated.

POTTIACEÆ. Basilar cells of the leaves

soft, pellucid, longer, mostly empty, rarely containing a persistent primordial utricle.

ORTHOTRICHACEÆ. Basilar cells of the leaves with only the very lowest soft, the upper mostly thickened, rarely pellucid and normal.

PRASI'OLA, Meneghini.—A genus of Ulvaceæ (Confervoid Algæ), separated from *Monostroma* by the arrangement of the quadrigeminate cells of the frond in lines, with wide intercellular walls; from *Ulva* by the existence of only a single layer of cells, and from both by the absence(?) of a reproduction by zoospores; from *Schizogonium* by the frond consisting of expanded plates. The species are included under *Ulva* (the terrestrial forms) in the *Br. Flora* and Harvey's *Algæ*, ed. 1. They have been carefully examined by Jessen, who finds the fronds proliferous at the margins; the "spores" he describes as consisting of motionless cells formed of the entire contents of the cells of the frond, set free by the solution of the parent cell. The reproduction of this group seems to us to require further investigation. Jessen includes here *P. calophylla* (Pl. 3. fig. 19), *crispa*, *furfuracea*, and a form which he names *P. stipitata*, differing from the last chiefly in the narrowly wedge-shaped, stipitate character of the frond: probably the last three constitute only varieties of one species.

BIBL. Jessen, *Prasiolæ Monog.* 1848; Harvey, *Br. Alg.* 171; Hassall, *Alg.* 297, pls. 77, 78; Kütz. *Sp. Alg.* 472; Rabenht. *Alg.* iii. 308.

PREPARATION of microscopic objects for examination and preservation.—Some remarks on the former point will be found in the INTRODUCTION, p. xxxii; and under many of the general and special articles, such as Diatomaceæ, Ovule, &c., directions are given. A few general remarks may still however be made in this place.

The parts of bodies or objects are usually separated by the mounted needles under a dissecting microscope, or by means of sections, according to the nature of the views which it is desired to obtain. With regard to the former operation, it need be merely observed that it is generally to be performed under water, in a watch-glass, glass cell, or other convenient holder.

The preparation of sections is a more complicated process. Soft parts of animals are best sliced by means of a Valentin's knife; but firmer structures, such as horn, may be cut with a sharp razor. Vegetable structures in general are sliced with a razor, which must be kept very sharp, and rubbed on a strop frequently while in use, and always before putting away. Fresh stems, thick leaves, &c., may be simply held in the fingers; thin objects, such as leaves, petals, &c., are best placed in a split cork or piece of carrot, the halves of which are kept together by insertion in the neck of a vial or a test-tube, which at the same time serves as a handle. Sometimes it is advantageous to immerse objects, especially soft or very small ones, in thick mucilage of gum-arabic, and to allow this to dry until tough enough to be cut by the razor; the slices are freed from gum by immersion in water. Dry objects, such as wood, dried leaves, seeds &c., must be softened by soaking in water before slicing. Small firm objects, such as softer seeds, are mostly sliced when fixed in a bit of white wax or stearine, which may be done by placing them on the surface of the latter, and stirring them into the substance melted by the application of a hot wire. Most sections of vegetable objects are obscured by air-bubbles engaged in the intercellular passages, &c. In old wood and similar objects immersed in liquid, the air is readily driven out by heat; in fresh structures, where heat may coagulate or dissolve matters, the air may be allowed to dissolve or escape by itself, which requires time, or it may be removed by exhaustion under an air-pump.

Sections of wood, &c., which are to be mounted in liquids, should be soaked for some little time in spirit or turpentine, to remove resins, &c. The Section-cutter is used for slicing such objects; but this is not of much use except when large numbers of very perfect sections of the same kind are required for purposes of sale, &c.

It need scarcely be said that sections require to be made in various directions in studying objects by these means. Thus stems should be sliced horizontally, and perpendicularly both parallel and at right angles to the medullary rays. When working with high powers, it is necessary to be on our guard against appearances of striation or fibres which may be produced by the fine notches in the cutting instrument.

The structure of laminated shells, &c., may often be seen in fragments broken off by the point of a knife. But sections of bone, shell, &c., are best made by sawing off thin pieces with a frame-saw having a watch-spring blade, grinding them down

upon a water-of-Ayr or some other stone, and polishing them upon a clean leather hone or strop with putty-powder and water, finally upon a dry hone alone.

Sections of very hard substances, as agate, &c., are so easily made by jewellers, that a description of the process is scarcely necessary. They are cut by means of a rotating circular iron plate, its margins being coated with a mixture of oil and diamond-dust. They are then ground upon a plate of metal with emery-powder and water, and polished upon a flat surface of pitch with putty-powder and water.

In grinding and polishing sections of hard structures, it is often requisite to cement them to a slide with Canada balsam, heat being applied until the balsam has become so hard as to fix the section firmly to the slide. As soon as one side has been polished, the section is removed from the slide, the balsam being rendered soft by heat, the polished side cemented to the glass, and the other side polished. The balsam may afterwards be separated from the section by maceration in oil of turpentine, benzole, &c.

The more delicate animal tissues require hardening before section. This is usually produced by freezing in the section-cutter; or by maceration in chromic-acid mixture (15 grs. of chromic acid to the pint of water, with ½ a pint of methylated spirit), bichromate of potash (180 grs. to the pint), osmic acid, or Müller's liquid (composed of 220 grs. of bichromate of potash, 90 grs. of sulphate of soda, and a pint of distilled water). These liquids require to be poured off and replaced until the tissue is sufficiently hardened.

Great care is required in the interpretation of the appearances presented by minute objects or portions of tissue, as to the influence of the liquids in which they are immersed; even water often totally distorts their natural appearance, as in the case of pollen, &c. And in animal tissues, the liquid of the allantois, blood-serum, or iodized serum or albumen (p. 441), are often useful as corresponding nearly to the liquid in which they are naturally immersed, and so producing but little change.

Besides these methods of preparation, there are those which enable the observer to keep sections or minute plants and animals under continuous examination without becoming dry, to provide a proper and equable or even higher temperatures to parts or the whole of organisms, and to add gases to the fluid surrounding the object. Recklinghausen's moist chamber fulfils the first requirement; and Stricker's slide, which is heated by means of the galvanic current, is most useful in producing constant amounts of heat. Stricker's gas-chamber, slide, and its conducting tubes enable carbonic acid, oxygen, hydrochloric acid, or any other gas to be applied to the fluid under examination. A substitute for those complicated pieces of apparatus, may be made by procuring a flat strap-shaped piece of metal, to be fixed upon the stage, with an aperture near one end corresponding with that in the stage. The slide is placed upon this, and a feeble flame of a spirit-lamp applied to the other end, will serve to produce the gentle heat required to set in motion or continue the amœboid movements of organisms.

The preparation of many objects requires the process of dyeing or STAINING.

BIBL. Beale, *How &c.*; Carpenter, *Microscope*; Frey, *Mikr.*; Stricker, *Hist.*; Gerlach, *ibid.*; Rutherford, *Hist.*; Mouchet, *Mn. Mic. J.* iii. 75; Flemming, *Schultze's Archiv*, ix. 123; Grönland, Cornu, and Rivet, *Prép. Micros.* (*Botanical*), 1871, *Qu. Mic. Jn.* 1872, 82; L. Clarke, *Phil. Tr.* 1851; Minot, *Mn. M. J.* xviii. 97; Meyer, *Arch. Mik. An.* xiii.; Moseley, *Qu. Mic. Jn.* 1872, 374, 379; Pritchard, *Qu. Mic. Jn.* 1872, 380; Ranvier, *Hist. tech.*; Marsh, *Section-cutting*; Betz, *Schultze's Archiv*, ix. 101; *Qu. Mic. Jn.* 1873, 343; Gibbs, *Hist.* 1880.

PRESERVATION of microscopic objects.—Under this head we shall consider the arrangement of microscopic objects for permanent preservation, supposing that they have been prepared (PREPARATION) in such manner as to render this possible.

Dry objects, or those which exhibit their structural peculiarities in the dry state.—These are sometimes mounted alone, at others when immersed in some preservative compound.

In the dry and uncovered state, they are occasionally mounted upon disks of cork, leather, or pasteboard, the surface upon which the object is to be placed being blackened by a coating of very fine lamp-black mixed with warm size or gum-water, or by a piece of dull black paper pasted upon it; the simplest way of making the disks is to paste black paper upon thick soft leather, and cut out the disks with a punch, like gun-wads. The object is fastened to the disk with

a little solution of marine glue in naphtha, or with gum. The disks are sold in the shops. They are usually transfixed with a pin, by which they may be fixed in the forceps under the microscope, and may be fastened to the bottom of a box lined with sheet-cork when not in use. The advantage of this plan is its simplicity; its greater disadvantage, however, is that the objects are liable to injury, and become covered with dust. It answers very well for common objects, seeds, minute lichens, &c.; but when the objects are of value, they should be mounted in a cell.

The cell may be made of a square piece of card-board or pasteboard, of suitable thickness, with a hole punched in the middle, fastened to a slide by marine glue or Canada balsam—the object being fixed to the slide by a little of either of the above cements, and a thin glass cover cemented to the card-board. Or the whole may be fastened together with paste—first a piece of black paper upon the middle of the slide, then the perforated square, next the object, and lastly the cover. The square of pasteboard may be replaced by a glass ring, a perforated square of glass, or a piece of sheet gutta-percha.

When the objects are minute or very thin, the square of pasteboard may be dispensed with, and they may be mounted thus: they are to be laid upon a slide, and a cover of thin glass placed upon them; a piece of paper larger than the cover, with a portion cut from the middle larger than the object, is then covered with paste, and a minute or two allowed to elapse, that the paper may become thoroughly imbued with it, the superfluous paste being removed with the paste-brush; the paper with the pasted side downwards is then laid upon the cover and the adjacent portions of the slide, and gently pressed with a cloth, that it may be accurately applied to the glass surfaces. The whole is then allowed to dry. The principal point in this process is the complete removal of the superfluous paste before the paper is applied. If this be not effected, it will be drawn by capillary attraction between the cover and the slide, and reaching the object, will spoil it.

A very secure method of mounting dry objects which are not altered by heat, consists in laying a ring or square of black japan upon a slide, the thickness of the layer being adapted to that of the object, and applying a pretty strong or long-continued heat until the cement becomes perfectly hard when cold. The object is next placed within the ring, a cover laid on, and heat applied until the cement becomes liquid. Gentle pressure then brings the cement and the margins of the cover into contact; and when the cement becomes cold, the cover is firmly fixed to the slide.

Another method of fastening the cover to the slide is by the use of electrical cement and balsam (CEMENTS, p. 150) mixed with 1 or 2 parts of tallow.

Many dry objects can be well preserved by *Mounting in Canada Balsam.*—When this is to be done, care must be taken that they are thoroughly dry; otherwise they will acquire a milky appearance, from being surrounded by minute drops of water. Some objects in drying curl up or become deformed, although their minute structure may not be essentially changed; this may be prevented by confining them between two slides tied together with thread, or held together by india-rubber rings, sealing-wax applied at the two ends, or by a folded strip of brass with the ends riveted. If the objects be of tolerable size, they are then soaked in oil of turpentine kept in an ointment-pot covered with a lid, for some hours, or even days, until the air is entirely displaced from them by the turpentine. The latter will often also remove the colouring-matter from some objects, as parts of insects, which may or may not be desirable; hence the duration of the process must vary accordingly. A clean slide is then warmed over the flame of a spirit-lamp, or upon a stove, and some clear balsam placed in the middle of it, and rendered more liquid by further gentle heat; the object is next carefully removed from the turpentine with forceps, drained and laid upon the warm balsam. Some more balsam is then allowed to fall from the warm wire (BALSAM) upon the object; and when this is well covered with it, a warmed cover is gently laid upon its surface. The superfluous balsam then escapes at the sides of the cover; and this should be aided by gentle pressure. The slide is next maintained at a gentle heat upon a warm mantelpiece, or a piece of tin-plate, until when allowed to cool, the balsam is perfectly hard. As soon as this is the case, the superfluous portions are cut away or scraped off with a knife, the surfaces of the glasses cleaned from any residue by a cloth wetted with turpentine or benzole, and some sealing-wax varnish applied

to the edges of the cover and the adjacent portions of the slide.

The success of the operation depends mainly upon two circumstances, viz. the object having been thoroughly dried, and the exclusion of air-bubbles. The former constitutes no difficulty, time being all that is required; but the latter requires that the object shall previously have been thoroughly moistened with the turpentine, and that the balsam shall have been added to the object, when laid in the balsam upon the slide, before so much of the turpentine has evaporated as will allow air to enter any minute cavities in the object. The heat applied should also be gentle; and if the direct flame of a spirit-lamp be used, its application should be made rather to some portion of the slide near that upon which the object is placed, than directly beneath the object. If much heat be applied, bubbles of the vapour of the turpentine will often disfigure the object for a time; but these will vanish as the object becomes cool.

If air-bubbles have found their way into the object, the slide must be macerated in oil of turpentine until the balsam is dissolved and the object liberated, and a fresh mounting made.

If the object be large, it must be mounted in a cell. A glass ring (sold in the shops) of suitable thickness must first be cemented to the slide by balsam; more balsam is then added until the cavity is filled, the object next added, and the cover applied.

If the object be minute, its removal for maceration in the turpentine is not requisite, and might entail the loss of the object. It must then be laid upon a slide, a drop or two of turpentine added, and the whole warmed until no air-bubbles are visible. The cover is then removed, most of the turpentine drained off, balsam added from the warmed wire, and the cover applied as before: or balsam may be placed upon the slide near the margin of the applied cover; and on applying a continued gentle heat it will find its way under the cover, and replace the turpentine as it evaporates.

If air-bubbles remain in parts of a minute object, a cover should be applied, turpentine added, and the slide held over a lamp until the turpentine boils, and the bubbles disappear on cooling. The cover is then removed, most of the turpentine allowed to evaporate, the balsam added, and the cover re-applied. Gum dammara may be used in the same manner as Canada balsam.

Gum and Glycerine.—Objects which cannot be conveniently dried may be mounted in a solution of gum-arabic in glycerine; the manipulations are much the same as with balsam, except that no heat is required. *Glycerine jelly* is often used.

Mounting in Liquid.—The structure of many objects is so altered by drying that they require to be mounted in some preservative liquid. These, if of considerable size, must be mounted in glass cells.

The cells may consist of glass rings, *i. e.* portions cut transversely from pieces of glass tubes, of various sizes, according to the dimensions of the objects. In using these, the ring is first warmed in the flame of a spirit-lamp, being held by steel forceps; one of the ground surfaces of the ring is then covered with marine glue or balsam previously melted in the same flame; the surface of the slide to which the ring is to be cemented is then heated in the flame, and whilst it is hot the surface of the ring coated with the melted cement is applied to it, and the ring pressed firmly, so as to displace the superfluous portions. When cold, these are to be removed with the point of a knife; sometimes a little solution of potash, oil of turpentine, or naphtha is required for this purpose. The cell is then complete, excepting the lid or cover, which consists of a circular plate of thin glass, of slightly less diameter than that of the outer margin of the glass ring. The cell is now to be filled with the preservative liquid, the object placed in it, and the cover applied, being made to slide over the upper surface of the ring, so as to displace any excess of liquid, and prevent the admission of air-bubbles. If the quantity of liquid first put into the cell be not sufficient, more must be added, until slight excess is present; the superfluous portions may be removed by a piece of blotting-paper, and the margin of the cover and ring very carefully wiped clean with a silk handkerchief, so that the surfaces may be free from all traces of the preservative liquid. The exposed parts of the upper surface of the glass ring, and the adjacent margins of the cover, are then to be coated lightly with one of the liquid cements, by means of a camel's-hair pencil; and when the first coat is dry, another must be laid on, so that the edges of the cover and the adjacent parts of the glass ring may be firmly cemented together, and the cell completely closed, to prevent the evaporation of the contained liquid.

The important points in this process are,

that the heated cement used to fasten the ring to the slide must accurately coat every portion of the two surfaces in apposition, and that the surfaces to which the liquid cement is applied must be perfectly clean and dry, so that the cement may come into contact with the surfaces of the glass. Rings of India-rubber and gutta-percha are very useful instead of glass.

When the objects are very large, the rings may be conveniently replaced by cells constructed of slips of glass, arranged so as to constitute four sides of a box, the bottom of the box being formed by the slide, and the top by a plate of thin glass: the pieces should be cemented together by marine glue.

Smaller cells may be made with marine glue, melted, dropped upon a slide and flattened whilst warm with a piece of wetted glass, the superfluous portions and central portion cut away with a knife. Should the marine glue become loosened from the slide, it may be re-fastened by heat; and if the upper surface be not perfectly flat, it may be made so by grinding with emery-powder and water upon a plate of metal or upon a stone.

Minute objects may be mounted in liquid in a variety of ways, the choice of which will vary with their nature. They are generally mounted in shallow cells, the sides of which are formed by varnish.

The old method consisted in placing the object upon a slide, adding a drop or two of the preservative liquid, applying the glass cover, adding more of the liquid, or removing excess with blotting-paper, until the space between the slide and cover was accurately filled, then applying to the margin of the cover and the adjacent portions of the slide a coat of some liquid cement, as gold-size, asphalt solution, black japan, &c. Objects thus mounted keep well for a time; but the cement soon apparently runs into the space between the cover and the slide, and the object becomes spoiled. It is often requisite, however, to mount an object in this way, which may be lying upon a slide, perhaps in some peculiar position which it is important for it to retain; when this is the case, the electrical cement with balsam and tallow should be used: and there is less fear of change, provided spirit be not used as the preservative liquid.

Whenever it is possible, then, a cell-wall should be previously formed, by laying a ring or square of one of the liquid cements upon the slide with a camel's-hair pencil, and applying a continued heat until it becomes thoroughly hard when cold. The cements generally used are:—asphalt solution; gold size with which a little finely powdered litharge has been well mixed, immediately applied, as it soon hardens; sealing-wax varnish; solution of marine glue in naphtha, or of Canada balsam in benzole or chloroform, or the balsam alone. Allport's liquid marine glue is very useful. If the upper surfaces of the rings or squares formed of these compounds, when thoroughly dry and hard, be not perfectly flat, they may be made so by grinding alone, or with emery and water, upon a piece of metal, marble, or a stone. The object is then placed in the cell, the preservative liquid added, and the cell closed as above described.

The following are the most important preservative liquids and compounds:—

Thwaites's liquid is thus prepared: to 16 parts of distilled water add 1 part of rectified spirit, and a few drops of creosote sufficient to saturate it; stir-in a small quantity of prepared chalk, and then filter. With this liquid mix an equal measure of camphor-water, and before using, strain through fine muslin. Used for preserving freshwater Algæ, as having but little action upon the endochrome.

Ralfs's liquid.—Prepared with bay-salt and alum, of each a grain, distilled water 1 oz.; dissolve. Forms a readily prepared substitute for the former in the preservation of the Algæ (Desmidiaceæ).

Hantzsch, quoted by Carpenter, produced a fine preservative medium for minute Algæ; composed of 3 parts of alcohol, 2 of distilled water, and 1 of glycerine; and the object, laid in a cement-cell, is covered with a drop, and placed under a bell-glass. Alcohol and water evaporate, and leave the glycerine: more is added time after time, and the cell is thus filled.

Acetate of alumina.—1 part of the salt to 4 parts of distilled water. Topping finds this the best preservative for delicate vegetable colours.

Distilled water. — Very often used for preserving Algæ; but perhaps camphor-water would be better.

Camphor-water is prepared by digesting distilled water with a lump of camphor.

Spirit and water.—Proof-spirit is prepared by mixing 5 measures of rectified spirit with 3 of distilled water. It is frequently

used for preserving animal structures, organs, injections, &c. Delicate preparations may be kept in a mixture of 1 part of spirit with 5, or even 10, parts of water. Dilute spirit should never be used as a preservative when it can possibly be avoided, on account of its action upon the cements. Methylated spirit is very useful, on account of its cheapness and strength; may be used when diluted in preserving large specimens of animal tissue.

Creosote water is prepared by filtering a saturated solution of creosote in rectified spirit, mixed with 20 parts of water. It is recommended for preserving preparations of muscle, cellular tissue, tendon, cartilage, &c.

Arsenious acid.—A preservative liquid is made of this substance by boiling excess of the acid with water, filtering the solution, and adding 2 parts of water. It is a very good preservative of animal tissues. Arsenite of potash, 1 part dissolved in 160 of water has been found useful for preserving the primitive nerve-tubes.

Corrosive sublimate.—A dilute solution of this substance is useful in the case of the blood-corpuscles, nerve, muscular fibre, &c.

Salt (chloride of sodium) and water, 5 gr. to the ounce, was long since recommended for the preservation of tissues, but is not much used, because fungi are apt to grow in it, which might, however, be prevented by saturating it with camphor by digestion. Corti has found a tolerably concentrated solution the best preservative for the delicate structures and nerve-cells of the internal ear. Carpenter recommends sea-water, with one tenth part of alcohol and one tenth of glycerine, for preserving the delicate marine organisms.

Carbonate of potash.—1 part dissolved in from 200 to 500 of distilled water, is a good preservative of the primitive nerve-tubes. Solution of acetate of potash is also useful.

Glycerine.—This is the most valuable of all liquids for vegetable preparations, which may be closed air-tight or not at pleasure. Dissections covered with a glass may be left in it from day to day, remaining unchanged and always ready for examination. Objects may be mounted in it, as with chloride of calcium. It is one of the most valuable fluids for the preservation and preparation also of animal tissues. Camphor-water and naphtha and water may be added.

Glycerine and Gum (Farrant's compound).—Pure gum-arabic 1 oz., glycerine 1 oz., water 1 oz., arsenious acid 1½ grain; dissolve the arsenious acid in the water, then the gum, without heat, add the glycerine, and incorporate with great care to avoid forming bubbles.

Gum-water (see CEMENTS).—The solution should be very thick, so as to flow with difficulty from the end of a wire. It may be used like balsam, but without heat. The residue is very apt to crack when dry; this may be prevented by applying a thick coating of varnish around its margins.

Chloride of calcium (CALCIUM, chloride of).—Objects may be mounted in this solution without closing the cell, by pasting two narrow strips of paper transversely upon a slide, leaving a greater interval than the breadth of the object; the latter is then laid upon the slide, a small quantity of the solution added, and a cover applied. The solution must not touch the paper. The cover may be fixed to the paper on the slide by the electrical cement with balsam and tallow. It is best, however, to close the cell.

Chloride of zinc. This is an excellent preservative of animal tissues for microscopic examination. It exerts a slight coagulating action, but this is not sufficient to seriously impair the peculiarities of the objects, and large portions of all structures which may require to be examined should be kept in it. The ordinary strength is 20 grs. of the fused chloride to the 1 oz. of water. A lump of camphor should be kept floating upon the surface of the solution in the stock-bottle.

Goadby's solutions.—These are of three kinds. The first (A) is made with—bay-salt (coarse sea-salt) 4 oz., alum 2 oz., corrosive sublimate 2 grains, boiling water 1 quart. This is too strong for most purposes, and is only to be employed where great astringency is required to give form and support to delicate structures.

The second (B) is made with—bay-salt 4 oz., alum 2 oz., corrosive sublimate 4 gr., water 2 quarts. This is recommended for general use, and as best adapted for permanent preparations. Mr. Thwaites uses it for marine Algæ; but we have found chloride of calcium answer for this purpose, and it is much more secure. Schultze recommends it for preserving *Medusæ*, Echinodermata, Annelid larvæ, Entomostraca, Diatomaceæ, Foraminifera, and Polycystina, both the hard and the soft parts, and advises the use of glycerine afterwards to produce transparence.

When carbonate of lime exists in the

preparations, as in the Mollusca, the following (C) should be used:—take of bay-salt 8 oz., corrosive sublimate 2 grains, water 1 quart. Marine animals require a stronger liquid (D) of this kind, made by adding about 2 oz. more salt to the last.

Pacini's modification is made with corrosive sublimate 1 part, chloride of sodium 2 parts, glycerine 13 parts, and distilled water 113 parts. The mixture should be kept for two months; and in use, 1 part should be diluted with 3 parts of water, and filtered. It is good for the preservation of blood-corpuscles, nerves, ganglia, and morbid cell-structures.

Salicylic acid. Edwards found that a saturated solution kept *Volvox* well.

Deane's compound.—This is made with—gelatine 1 oz., honey 5 oz., water 5 oz., rectified spirit ½ ox., and 6 drops of creosote. The gelatine is soaked in the water until soft, the honey added, the mixture then boiled, and when it has cooled somewhat, the creosote mixed with the spirit added; lastly, it is filtered through fine flannel. This is used warm.

That preservative liquid should always be chosen which exerts least action upon the structure of the object which it is requnded to preserve.

If drying the object does not destroy its peculiar structure, and the object is not very transparent, the balsam should be used.

If the structure be destroyed by the process of drying, and the object be not impaired by endosmosis, the chloride of calcium or glycerine is best. Other circumstances may render these preservatives desirable: thus the minute parts of the mouth of the Acarina are best seen and preserved in balsam, whilst the general form of the body is best retained when the animals are immersed in chloride of calcium or glycerine.

Objects to be mounted in a preservative liquid should be placed in a watch-glass. If they are alive they may be placed in water, and as much of this as possible should be poured off or removed with a pipette or blotting-paper, and the preservative liquid added, and this operation repeated that the water may be entirely displaced.

The liquid cements used to close the cell should be applied in several layers, each being allowed to dry before the next is applied.

The preservative liquid must not be capable of exerting any action upon the cements used in making or closing the cell.

If chloride of calcium or glycerine be used as the preservative liquid, when the first coat of liquid cement used to close the cell has become dry, the slide and cover should be washed gently with a sponge and distilled water, then dried with blotting-paper or a silk handkerchief, and the next coat of varnish applied.

The great difficulty is to permanently preserve moist objects; for whatever may be the cement used, watery liquids almost invariably escape in time, although the preparations may remain good for some years. No perfect cement is known, which on thoroughly drying retains its hold on the slide. Objects mounted in glycerine keep best; but in many instances the structure is entirely destroyed by it. This difficulty may be often overcome, by adding very diluted glycerine to the object at first, replacing it gradually by stronger as the water evaporates, until at last the object becomes really mounted in pure glycerine.

Many moist objects may also be mounted in balsam or dammara-solution, by first macerating them in weak alcohol, then in stronger, next in oil of cloves, and finally in balsam.

Even objects mounted in balsam are not safe; for when the balsam becomes really dry, it separates from the slide, and air runs in. Balsam thinned with turpentine, and gradually added, perhaps with the aid of gentle heat, will, however, restore the original condition. And the cement around older objects should be varnished occasionally with dilute balsam or dammara-benzole solution.

The deeper the cell, the less the chance of the object being spoiled.

As soon as objects are mounted, the slides should be labelled with a square or circular piece of paper pasted upon them, the name and other particulars being expressed in writing. The name &c. may also be written upon slides with a diamond: but the paper labels should always be used; otherwise much time will be lost in searching for and distinguishing particular objects in the cabinet.

For preserving dried plants from mould and insects, the old method was to brush them with a solution of a grain or two of corrosive sublimate dissolved in an ounce of spirit. The "Kew mixture" for the same purpose, is made with corrosive sublimate and crystallized carbolic acid, of each ½ oz., methylated spirit a pint. Perhaps

¼ of this strength is sufficient for general use. The same may be applied to insects in the cabinet, by means of a hair-pencil. Berkeley points out that carbolic acid alters the colour of some fungi.

BIBL. Treatise upon the Microscope (INTROD.); Corti, *Sieb. und Köll. Zeit.* iii. 134; Goadby, *Amer. J.* xiii. 15; Davies-Matthews, *Mounting*; Mohl, *Bot. Zeit.* xv. 249; Beale, *How*; Carpenter, *Microscope*; Frey, *Mikr.*; Stricker, *Hist.*; Heys and Hepworth, *Tr. Mic. Soc.* 1865; Lawrence, *Qu. Mic. Jn.* 1859, 257; Walmsley, *Mn. Mic. Jn.* i. 380; Bastian, *ibid.* i. 94; Mouchet, *ibid.* iii. 75; Bachmann, *Anf. mik. Präparat.*

PRIMI'TIA, J. & H.—A small fossil Ostracode with suboblong valves, impressed with a variable furrow or pit in the mediodorsal region. Forty species in the Silurian rocks of Britain, Europe, and America.

BIBL. Jones & Hall, *Ann. N. H.* 3. xvi. 415.

PRIMORDIAL UTRICLE.—This term indicates a peculiar portion of the contents of the cellulose sac constituting a vegetable cell. As the formations comprehended under this name are of great importance in the development of vegetable cells, a little detail must be entered into in explaining the subject.

If a cell of the pulp of any succulent fruit, a cell of yeast, or cells in sections taken from the delicate nascent tissues of any growing part of plants, are placed in water, the entire contents will soon be seen to retract from the cellulose wall, leaving a clear space, filled with transparent liquid, between the latter and a sharply defined line bounding the contracted or coagulated contents (Pl. 47. figs. 1, 2, 10–12). The addition of tincture of iodine makes the conditions still more clear. If the parent cells of pollen-grains or spores are treated thus, just before the development of the cellulose wall of the special parent cells (see POLLEN), the four portions of the contents of the parent cell contract and separate, and each portion, containing its own granular structures and nucleus, appears bounded by a well-defined line (fig. 607). This well-defined line presents in this condition the appearance of a delicate membrane or pellicle enclosing the entire contents. The action of acids, or spirit, and iodine, reveals the existence of a similar set of conditions in all actively vegetating cells; and in most cases a more or less thick viscous layer of the protoplasm is found lining the cellulose wall before the application of the reagents. Since the line indicating the boundary of the contents can not be distinctly seen until the contents have retracted from the cellulose wall, and since the protoplasm is always coagulated by the action of the reagents, it

Fig. 607.

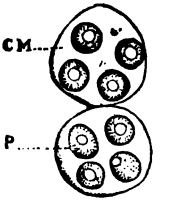


Fig. 608.

Fig. 607. Parent cells of pollen-grains just after the separation of the contents into four portions, treated with iodine. *C M*, the parent cell. *P*, the protoplasmic portions, each with a nucleus and a well-defined outline at the surface of the primordial utricle. Magnified 250 diameters.

Fig. 608. Cells of Protococcus multiplying. The green granular contents are bounded by the definite outline of the primordial utricle: the primary and secondary cellulose parent-cell membranes are represented as separated from each other. Magnified 400 diameters.

is a subject of discussion whether the film forming the well-defined line on the surface of the contracted contents is a true structure, or only a pellicle produced by the coagulation of the surface of the protoplasm, just as a "skin" forms over size, or other similar substances when they dry up in the air. Very young cells often appear filled with a dense protoplasm (young antheridial cells of Cryptogamia, embryo-sacs of many flowering plants, cells about to produce zoospores in the Confervoids, &c.), which may produce numerous new cells by merely breaking up into separate portions; and thus the function of the primordial utricle is shared by the entire mass of contents. Young cells of nascent tissues, presenting this condition at first, acquire the primordial utricle afterwards, simply by the dense contents becoming excavated as the cell-wall expands, and following this in its growth, so that the originally dense homogeneous mass becomes a hollow sphere with the centre occupied by watery cell-sap; in other cases the originally homogeneous protoplasm becomes excavated by numerous water-vesicles, and thus honeycombed, until it forms a mere reticulation of protoplasmic threads upon the wall or stretched across the cavity. The protoplasmic layer lying upon the wall of the

cell presents a complex arrangement in some cases: Braun correctly distinguishes three layers in *Hydrodictyon*; there are three in *Chara*, where the intermediate one contains the chlorophyll-granules, and the innermost forms the circulating mass; a distinct layer is left after the discharge of the zoospores in *Cladophora*, &c. Thus, as explained under the head of CELL-formation, the primordial utricle or formative protoplasmic layer is the active agent in cell-division, and the layer forming the surface of the isolated portions of contents of parent cells produces the new cell-wall in all cases of free-cell formation, whether taking place in parent cells, or, as in the case of the zoospores of Algæ, after escape from the latter. Strassburger describes the primordial utricle as being radiately striated, especially when treated with osmic acid.

In many of the Algæ, some of the individual cells regularly exist for a certain period as masses of protoplasm devoid of a cellulose coat, as, for example, the spores of *Fucus* and its allies, and the active zoospores of Confervoids; and these bodies, although presenting a well-defined outline, do not appear to have a properly developed membrane on the surface, which merely appears to be denser than the semifluid central portion. These bodies withdraw themselves evidently from the definition of a vegetable cell as ordinarily given; nevertheless they constitute all the essential living part of a vegetable cell, and indicate most clearly the undoubted fact that the cellulose walls, that is to say all the really solid and permanent portions of vegetable structure, are mere skeleton or shell for the protoplasmic or nitrogenous structures.

BIBL. Mohl, *Bot. Zeit.* ii. 273; *Vermischte Schrift.* 362; Henfrey, *Ann. N. H.* xviii. 364; Nägeli, *Zeitschr. wiss. Bot.* 1844 & 1846; Braun, *Verjüng., Ray Soc.* 1853, 121; Cohn, *Nova Acta*, xxii. 605; Pringsheim, *Bild. d. Pflanzenzelle*, 1854; Hartig, *Bot. Zeit.* xiii. 393; Crüger, *ibid.* 601; Sachs, *Bot.* 43; Henfrey-Masters, *Bot.* 495.

PRITCHAR'DIA, Raben.—A genus of Diatomaceæ, comprising certain species of *Nitzschia* and *Synedra*. (Rabenht. *Alg.* i. 162.)

PROBOSCEL'LA, Kt.—A genus of Holotrichous Infusoria. Elongate-clavate, compressed, with an apical hook; mouth ventral; an undulating membrane between the front and mouth; with one or more caudal setæ. *P. vermina*; marine length 1-250″.

PROEMBRYO.—The term applied to the structure first produced from the germinal vesicle of Flowering Plants, after impregnation, consisting of the suspensor and the embryonal cell at its extremity. The proembryos of the Gymnosperms are especially remarkable (see OVULE). The same term is often incorrectly applied to the PROTHALLIUM, the cellular structure first produced in the germination of the spores of the higher Flowerless Plants.

PROROCEN'TRUM, Ehr.—A genus of Cilio-flagellate Infusoria.

Char. No eye-spot; carapace smooth, terminating in a point in front; flagellum single.

P. micans (Pl. 31. figs. 70 & 71), ovate, greatly compressed; length 1-430″.

BIBL. Ehr. *Inf.* 44; Clap. et Lach. *Infus.* 411; Kent, *Inf.* 461.

PROR'ODON, Ehr.—A genus of Holotrichous Infusoria, family Trachelina.

Char. Body covered with vibratile cilia, truncate in front; mouth with a cylinder of teeth; freshwater. Species numerous.

P. teres (Pl. 31. fig. 72). Body ovate, terete, white. Length 1-140″.

BIBL. Ehr. *Inf.* 315; Clap. et Lach. *Infus.* 318; Kent, *Inf.* 491.

PROSEN'CHYMA. See TISSUES, Vegetable.

PROSTHE'MIUM, Kunze.—A genus of Melanconiei (Coniomycetous Fungi), growing upon the branches of trees, forming circular depressed spots; the perithecia

Fig. 609.

Prosthemium betulinum.
Spores and paraphyses seen in a vertical section of frut. Magnified 200 diams.

enclose erect articulated filaments bearing radiating tufts of two or three septate spores (fig. 609). *P. betulinum* occurs upon the bark of the branches of the birch tree. The species are mere forms of *Sphæriacei*.

BIBL. Berkeley, *Brit. Flor.* ii. pt. 2. p. 297.

PROTAMŒ'BA, Haeckel.—A genus of Protista.

Char. A simple shapeless protoplasm-body without vacuoles, with simple pseudopodia, not ramifying nor anastomosing; reproduction by fission.

Species. *Protamœba primitiva.* Protoplasm-body of 0·03–0·05 millim. diameter, continually varying in form, with one or several (3 to 6) peripheral pseudopodia. Processes short, rounded, obtuse, finger-shaped, at most as long as the diameter of the central body. Freshwater, near Jena. (Haeckel, *Gen. Morphol.* 1866, i. 133.)

PROTEA'CEÆ.—A family of Dicotyledonous plants, mostly from New Holland or the Cape, shrubs or small trees (*Banksia, Grevillea, Hakea,* &c.), of remarkably rigid, evergreen habit. The coriaceous leaves are well suited for the study of the epidermal structures; and the stomata have interesting peculiarities (see STOMATA). The epidermis is often scurfy with scattered hairs, some of which are of curious forms (Pl. 28. fig. 29).

PROTEON'INA, Williamson.—A simple Arenaceous Foraminifer; a feeble *Lituola* of the *Haplophragmium* group.

BIBL. Williamson, *Foram.* 1; Carpenter, *For.* 309.

PROTEUS.—An old name applied to certain Infusoria, as *Amœba* &c. Also a genus of Amphibia with large blood-corpuscles.

PROTHAL'LUS OR PROTHALLIUM.—The structure resulting from the germination of the spores of the Cryptogamia, in which the female, and sometimes the male organs are formed. See MARSILEACEÆ, LYCOPODIACEÆ, EQUISETACEÆ, and FERNS.

PROTISTA, Haeckel.—A kingdom of organic nature supposed to be intermediate between the animal and vegetable kingdoms, and comprising the so-called lowest forms of life. It is divided into the following groups:—

- I. Monera.
  - 1. Gymnomonera (*Protogenes, Protamœba,* &c.).
  - 2. Lepomonera (*Protomonas, Vampyrella, Protomyxa, Myxastrum,* &c.).
- II. Flagellata.
  - 1. Nudiflagellata (*Euglena, Spondylomorum,* &c.).
  - 2. Ciliioflagellata (*Peridinium, Ceratium,* &c.).
- III. Labyrinthulea (*Labyrinthula*).
- IV. Diatomea (*Bacillaria*).
- V. Phycochromaceæ.
  - 1. Chrysococcaceæ (*Glœocapsa, Merismopœdia,* &c.).
  - 2. Oscillarineæ (*Nostochaceæ, Rivulariaceæ,* &c.).
- VI. Fungi.
  - 1. Phycomycetes (*Saprolegnieæ, Mucorineæ,* &c.).
  - 2. Hypodermiæ (*Uredinæ, Ustilaginæ,* &c.).
  - 3. Basidiomycetes (*Hymenomycetes, Gastromycetes,* &c.).
  - 4. Ascomycetes (*Protomycetes, Discomycetes,* &c.).
- VII. Myxomycetes (Mycetozoa).
- VIII. Protoplasta (Amœboida).
  - 1. Gymnamœbæ (*Autamœba,* &c.).
  - 2. Lepamœbæ (*Arcella, Difflugia,* &c.).
  - 3 Gregarinæ (*Gregarina*).
- IX. Noctilucæ *Noctiluca.*
- X. Rhizopoda.
  - 1. Acyttaria (Monothalamia and Polythalamia).
  - 2. Heliozoa (*Actinosphærium*).
  - 3. Radiolaria (Monocytharia and Polycytharia).

BIBL. Haeckel, *Gen. Morph.*; *Mon. Moneren, Jenai. Zeit.* 6. iv. 1; *Biol. Studien,* 1; Wright and Kirby, *Qu. Mic. Jn.* 1869 & 1871; Kent, *Inf.* 44.

PROTOCOC'CUS, Ag.—A genus of Volvocineæ (Confervoid Algæ), at present very imperfectly known, since without a tolerably complete history of the development of the forms it is impossible to distinguish the true species of *Protococcus* from the young states of the more complicated Palmellaceæ, and even from the germinating gonidia of the Lichens. As we have limited it, *Protococcus* includes those unicellular Algæ which in the aquatic state consist of single zoospore-like bodies, with a more or less evident gelatinous cellulose envelope through which the two cilia protrude. They move actively, and are multiplied by division during the active state. Finally they settle down into a resting-stage; and they may then increase by vegetation so as to form granular patches. Mostly, however, those which settle down turn red and acquire a thick coat, passing through a stage of rest before they germinate again, apparently requiring to be dried up first. When they germinate, they frequently produce many generations of *still* forms before the active ciliated forms reappear, especially when placed on damp surfaces, and not in water. When placed in favourable circumstances, the resting-forms (even after several years) recommence the course of vegetation, reacquiring the green colour by degrees in the course of several generations of vegetative cells. The contents of the red

form appear to consist partly of oil-globules; in the green form the protoplasmic substance is coloured by chlorophyll, and at a certain stage contains starch.

We have traced *P. viridis* through all these stages, as represented in Pl. 7. fig. 2 *a–g*: a most elaborate monograph of *P. pluvialis* by Cohn goes to establish the same conclusion, that the genus *Hæmatococcus* is founded on states of *Protococcus*. The *P. viridis* of our figures is undoubtedly *Chlamidomonas*, synonymous with *Diselmis*, Dujardin. This form appears at first sight nearly allied to *Euglena*; but there are striking differences in the appearance and movements of the active forms, and the vegetative forms are somewhat different. It may be remarked, however, that the zoospores of *Protococcus viridis*, allowed to dry upon a slide, often turn red and look just like small *Astasiæ* (Pl. 7. fig. 2 *g*).

We have remarked under PALMELLA, that the Polar red snow appears to be a Palmella (Pl. 7. fig. 3 *d*), although this species has been called *Protococcus* and *Hæmatococcus nivalis*; and it appears to us that Shuttleworth and others have confounded this with *Protococcus pluvialis*. Hassall's species of *Hæmatococcus*, nos. 8 to 19, with the exception of *H. vulgaris* (*Chlorococcum*) (Pl. 7. fig. 1), are probably congeneric with our *P. viridis*.

Our *P. viridis* makes its appearance commonly on damp earth, sand, &c., forming a greenish coat of no perceptible thickness; and the zoospores (*Chlamidomonas*) occur constantly in standing pools in spring and autumn, tinging the surface of the water bright green, and, as they settle to rest, forming a kind of green scum at the margins, constituting the *green matter* of Priestley. Cells of resting-form 1-2400″ in diameter. *P. pluvialis* colours water red in like manner; it occurs on mountains, especially in melted snow-water. Cells of resting-form 1-1250 to 1-625″ in diameter. Similar colorations, however, are produced by various other organisms (see WATER).

It may be observed that when the active forms of *P. viridis* and *P. pluvialis* divide without coming to rest, they produce forms which are undistinguishable from many of Ehrenberg's species of Polygastrica. When they acquire a loose cellulose coat before losing their cilia, they represent *Gyges*; at other times they resemble *Chlorogonium*, *Uvella*, *Polytoma*, *Monas*, *Bodo*, &c.

BIBL. Harvey, *Br. Alg.* 1. 180; Hassall, *Fr. Alg.* 321; Meneghini, *Tr. Turin Ac.* 2. v. 1; Cohn, *Nova Acta*, xxii. 605, *Ray Soc.* 1853, 514; Von Flotow, *Nova Acta*, xx. 414; Braun, *Verjüngung*, *Ray Soc.* 1853, 206; Nägeli, *Einzellige Algen*; Kützing, *Sp. Alg.* 196; *Tab. Phyc.* i.; Rabenh. *Alg.* iii. 56; Cooke, *Fr. wat. Algæ*, 1882. See also RED SNOW.

PROTODER'MA, Ktz.—A genus of Ulvaceæ (Confervoid Algæ).

Char. Cells forming a thin membranocrustaceous expansion; they are roundish angular. *P. viride* (Pl. 3. fig. 18), freshwater; on stones; cells 1-300″.

BIBL. Ktz. *Phyc. Gen.* 295; Rabenht. *Alg.* iii. 307.

PROTOG'ENES, Haeckel.—A genus of Protista.

Char. A simple shapeless protoplasm body without vacuoles, which protrudes ramifying and anastomosing processes, and reproduces itself by fission. *Protogenes primordialis.* Body sometimes globular, from 1-200–1-25″ diameter, sometimes extended and flattened out, with irregular outline, to 1-10″ diameter; pseudopodia exceedingly numerous, over a thousand, very fine, with very numerous ramifications and anastomoses. Mediterranean.

BIBL. Haeckel, *Zeitschr. wiss. Zool.* xv. 1865, 360.

PROTOHY'DRA, Greef.—A genus of Zoophytes. Like *Hydra*; but simpler in structure, as it has no tentacles. Reproduction by transverse fission; nematophores and pigment-cells present.

BIBL. Greef, *Sieb. u. Köll. Zeit.* i. 1870; *Qu. Mic. Jn.* 1870, 297.

PROTOM'ONAS, Haeckel.—A genus of Protista.

Char. A simple protoplast, without vacuoles, simple or ramifying pseudopodia. Reproduction by zoospores, which combine into meshes or plasmodia.

Protomonas amyli. In decaying *Nitella*. (Haeckel, *Gen. Morph.* vol. ii. 23, *Qu. Mic. Jn.* 1869.)

PROTOM'YCES, Unger.—A genus of Fungi, the affinities of which are very doubtful; placed in Ascomycetes by Sachs, but apparently forming a degraded branch of Phycomycetes. They grow in the intercellular passages of leaves and leaf-stalks. According to De Bary, these Fungi consist of ramified filaments creeping between the cells of soft tissues, and swelling up at intervals (apparently where they meet an intercellular space large enough), to form globular

spores: a filament with several spores in course of division appears like a varicose tube; it is septate, however; and when the globular spores are mature, they have a double coat; in *P. macrosporus* the diameter of the ripe spore is about 1-5000″. When advanced in age, the mycelium appears to be wholly converted into spores, which become free. The existence of these Fungi is rendered more or less evident externally by warty projections of the epidermis, finally bursting. Unger describes four species—*P. macrosporus* occurring on *Ægopodium* and *Angelica*, *P. endogenus* (*Galii*) occurring on *Galium mollugo*, *P. microsporus* on *Ranunculus repens*, and *P. Paridis* on *Paris quadrifolia*. De Bary found a species on *Menyanthes*, with oval spores 1-800″ long and 1-1300″ broad. A species (*P. concomitans*) has lately been found on exotic Orchids.

BIBL. Unger, *Exanthem. d. Pflanz.* 341; De Bary, *Brandpilze*, 15, pls. 1 & 2, and *Beiträge*, i. 1864; Léveillé, *Ann. Sc. Nat.* 3. viii. 374; Tulasne, *ibid.* vii. 112; Fries, *Sum. Veg.* 517.

PROTOMYX'A, Haeckel.—A genus of Protista.

Char. A simple shapeless mass of protoplasm, with vacuoles, which protrudes ramifying and anastomosing pseudopodia. Reproduction by zoospores, forming plasmodia.

Protomyxa aurantiaca, orange-red; resting condition globular, with a thick structureless covering. Zoospores pear-shaped, with a strong flagellum at the pointed end, at first moving like the zoospores of the Myxomycetes, afterwards creeping like an *Amœba*. On empty shells of *Spirula*; Canary Islands. (Haeckel, *Gen. Morph.*; Bronn, *Klass. &c.*)

PROTOMYXOMY'CES, Cunn. — A genus of Myxomycetes. *P. coprinarius*, in the intestines of man, cows &c.; amœboid bodies not uniting. (Cunningham, *Qu. Mic. Jn.* 1881; Kent, *Inf.* 472.)

PROTOPLASM.—The name applied by Mohl to the colourless or yellowish, homogeneous or granular viscid substance, of nitrogenous constitution, which constitutes the formative substance in the contents of vegetable cells, in the condition of gelatinous strata, reticulated threads, and nuclear aggregations &c. It is the same substance as that termed by Dujardin in animals SARCODE.

Protoplasm is the simplest form which organized matter can assume, and which, without any other material peculiarities except a certain softness, transparency, and jelly-like condition, is capable of contracting, expanding, and assimilating. It is common to the animal and vegetable kingdoms.

See CELL, SARCODE, and PRIMORDIAL UTRICLE.

PROTOSPON'GIA, Kt.—A genus of Choano-flagellate Infusoria. Ovate, imbedded in a gelatinous matrix; flagellum single. *P. Haeckelii*; length 1-3000′; freshwater. (Kent, *Inf.* 363.)

PROTOZO'A.—A Subkingdom of the Animal Kingdom, characterized by the absence of distinct organs, the form and simple organization being reduced to those of a cell (Siebold). If the above definition be adopted, it must be remembered that the cell may be represented by the cell-contents only; and these we believe to constitute the essential part of a cell (see Edition 1856), which is now generally admitted.

The Protozoa form the lowest group of the Animal Kingdom. They are mostly minute, and aquatic, consisting of a mass of gelatinous protoplasm or sarcode. This is usually granular, often containing minute globules of fat, sometimes minute crystalline particles. Sometimes one or more nuclei are present, often they are absent. The body is naked in some, in others it is enveloped in a carapace or shell, which may be simply membranous, calcareous, as in the Foraminifera, or siliceous, as in the Polycystina and *Acanthometræ*. Movement is effected by pseudopodia, which are short and stout, or long and slender, processes of the protoplasm, sometimes branching and anastomosing to form meshes or plasmodia; by cilia; or by flagelliform filaments. There is no proper gastric cavity. The food-particles are in the lowest forms entangled and brought to the body by the pseudopodia, as in *Amœba* and *Actinophrys* &c., or ingested from all parts of the surface; while in many Infusoria there is a distinct mouth and anus. Contractile vesicles supposed to represent a circulatory apparatus are sometimes, but not always present. Reproduction is produced by fission, by conjugation, or by the breaking-up of the nucleus.

The Protozoa approach closely the lower and simpler forms of the Vegetable Kingdom; and very different views are held as to the characters by which they may be distinguished, and the organisms which belong to the two kingdoms.

An older character was, that animals subsist upon ingested organized matter, while plants prepare their food from un-

organized materials, as carbonic acid and ammonia. The other, that animals absorb oxygen and evolve carbonic acid, while plants evolve oxygen, cannot be applied generally in the case of these microscopic organisms. But certain Protozoa have no mouth, and cannot admit food-particles like *Amœba*, nor can organic matters be endosmosed by them. Movement has in late years been shown to be a property of protoplasm, limited where a cell-wall is present, yet it may be said to be universal. Stein and Kent consider the presence of a contractile vesicle to form a distinctive character; but its existence in *Volvox*, we think must invalidate this view.

The chemical property of the protoplasm, that of animals swelling and dissolving in solution of potash or ammonia, while that of plants is apparently unaffected, has also been called in aid; and this really appears to be the best individual test. Little attention has been paid to this part of the question, so that the older views must remain, until further experiments have been made. See ANIMAL KINGDOM, and the heads of the Classes.

BIBL. Siebold, *Vergl. An.* i.; Koch, *Icon. Hist.* 1865; Gabriel, *Gegenbaur's Morph. Jahrb.* 1875; Mereschowski, *Russl. Arch. mik. An.* 1878, xvi.; Butschli, *Bronn's Klass. &c.*; Kent, *Inf.* 1880, 31.

PSAMMOSPHÆ'RA, Schultze. — An Arenaceous Foraminifer, round, free or attached, made of coarse sand-grains and fine cement; common in deep seas. (Brady, *Qu. Mic. Jn.*, new ser. xix. 8.)

PSECA'DIUM, Reuss.—A globose or Glanduline *Marginulina*. Fossil.

BIBL. Reuss, *Sitz. Ak. Wien*, xliv. 368.

PSEUDOCALA'NUS, Boeck.—A genus of marine Copepoda. 2 sp. (Brady, *Copep., Ray Soc.* i. 44.)

PSEUDOCH'LAMYS, Clap. et Lach.—A genus of Arcellina (Rhizopoda). *P. nitella*; carapace brown, pseudopodia broad and short; in ponds. (Claparède et Lachm. *Inf.* 443.)

PSEUDOCYC'LOPS, Brady.—A genus of marine Copepoda. 2 sp. (Brady, *Copep.* i. 81.)

PSEUDOCYTH'ERE, G. O. Sars.—One of the *Cytheridæ*; valves very thin, obliquely quadrangular; five joints in upper, seven in lower antennæ, which are long and have long setæ; no eyes. 1 British species.

BIBL. Brady, *Linn. Tr.* xxvi. 453.

PSEUDODIFFLUGIA, Schlum. — A genus of Arcellina.

Char. Shell membranous, ovoid or ovoglobular, smooth or striped spirally, with a wide round opening whence issue pseudopodia. (Pritchard, *Infusoria*, p. 557.)

PSEUDOGONIDIA.—A term applied to bodies appearing in the interior of cells of Algæ, which are obscure in their nature, being either metamorphosed and isolated masses of protoplasm, or parasitic bodies resembling monads. They are apparently connected with the objects called CHYTRIDIUM and PYTHIUM. (Cienkowski, *Pringsheim's Jahrb. Bot.* i. 371.)

PSEUDOG'RAPHIS, Nyl.—A genus of Microlichens parasitic on Lecanoræ.

Char. Spores colourless or becoming brown, 4–6-locular, sometimes becoming submuriform; slightly blue with iodine.

BIBL. Lindsay, *Qu. Mic. Jn.* 1869, 352.

PSEUDOPO'DIA are the processes of protoplasm which are protruded from the bodies of the RHIZOPODA, serving for locomotion and the prehension of food.

PSEUDOS'PORA, Cien.—A genus of Flagellate Infusoria. Body naked, swimming or creeping; flagella two, equal; no mouth. *P. volvocis*, on and in *Volvox*; length 1-1250″. (Kent, *Inf.* 304.)

PSEUDOSPORES. — The apparent spores of *Uredinei* and *Tremellini*, which germinate and produce the real reproductive spores, which are then called *sporiola*.

PSICHOHOR'MIUM, Ktz.—This genus consists of species of *Conferva*, whose filaments are more or less incrusted with oxide of iron or carbonate of lime.

BIBL. Rabenh. *Fl. Eur. Alg.* iii. 324.

PSILO'NIA, Fr.—A genus of Sepedoniei (Hyphomycetous Fungi), consisting of little compact tufts of twisted filaments, at first covering the fusiform, globose, or oval spores, which arise from the wart-like protuberances on the central filaments, and soon become free. They are found on dead wood or on reeds. *P. nivea*, which is common on the bark of beech-trees, is the product of an insect, *Adelges fagi*.

BIBL. Berk. *Br. Fl.* ii. pt. 2. 353; *Ann. N. H.* 2. viii. 179; Fries, *Sum. Veg.* 495.

PSILOTEÆ.—A family of Lycopodiaceous plants, distinguished by their many-celled sporanges, varying much in habit and external appearance.

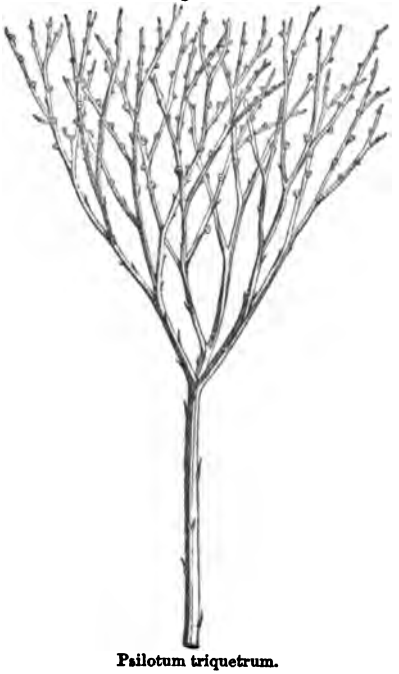
Synopsis of Genera.

Psilotum. Sporanges sessile, three-celled, busting imperfectly into three valves by a vertical crack, filled with mealy spores.

Tmesipteris. Sporanges sessile, three-celled, bursting imperfectly into two valves by a vertical crack, filled with mealy spores.

Isoëtes. Sporanges imbedded in the bases of the leaves, and adnate at the back, not valvate, with several transverse septa; containing two kinds of spores (in distinct sporangia).

Fig. 610.



Psilotum triquetrum.
Nat. size.

Fig. 611.

Fragment of a branch of Psilotum triquetrum.
Magnified 10 diameters.

PSILOTRICHA, St.—A genus of Hypotrichous Infusoria. Body oblong, flattened, with 2 rows of long ventral, and a peripheral row of setæ, but no styles. *P. acuminata*, freshwater. (Kent, *Inf.* 672.)

PSILO'TUM, Swartz. (*Lycopodium nudum*, L.).—An exotic genus of Psiloteæ (Lycopodiaceæ), remarkable for their trilocular capsules and minute leaves (fig. 611).

PSORO'MA, Nyl.—A genus of Lichenaceous Lichens, with large distinct gonidia.

Bibl. Leighton, *Lich. Flora*, 149.

PSOROP'TES, Gervais.—A genus of Arachnida, of the order Acarina, and family Acarea.

Char. Body soft, depressed, with rigid hairs beneath, and on the legs.

Parasitic upon the horse and sheep, and the ox.

P. equi (Pl. 6. fig. 18), itch-insect of the horse. Found upon the scaly crusts formed upon the body. Mandibles elongate, didactyle, each terminated by two teeth; palpi three-jointed, and adherent to the labium; ventral surface covered with parallel undulating rugæ; at the end of the body are two fleshy lobes, terminated by a tuft of setæ.

Bibl. Hering, *Nov. Act.* xviii. 585; Gervais, *Walckenaer's Aptères*, iii. 266; Dujardin, *Micr.* 147; Murray, *Ec. Ent.* 307; Mégnin, *Paras.* 189.

PSOROSPERMIÆ.—These bodies were discovered by Müller, and appear to represent the pseudo-naviculæ of the *Gregarinæ* of fishes.

They are microscopic, oval, depressed, or discoidal corpuscles, with or without a tail, exhibiting no movements, and consisting of a tolerably firm outer coat, containing one or two oblong contiguous vesicles at that end of the body opposite the tail. They are about 1-2500 to 1-2000″ in length, and are contained in immense numbers in minute cysts, in almost every part of the body of fishes, as upon the gills, in the muscles, and between the coats of the eye, in the swimming-bladder, &c. Sometimes they are imbedded in a ramified sarcodic mass.

Diameter of the cysts on the pike 1-50 to 1-25″; of the corpuscles, length 1-2000″, breadth 1-3500″. See Pebrine.

Bibl. Müller, *Archiv*, 1841. 477, 1842. 193; Creplin, *ibid.* 1842. 61; Dujardin, *Helminthes*, 643; Leydig, *Müll. Archiv*, 1851, 221, *Mic. Jn.* 1853, i. 206; Robin, *Végét. Parasit.* 2. 291.

PTERID'EÆ.—A family of Polypodiaceous Ferns. Genera:

Adiantum. Sori marginal, linear or globose, numerous and distinct, or confluent. Indusium shaped liked the sorus, formed of the reflexed margin of the fronds, with the capsules beneath.

Ochropteris. Sori marginal, transversely oblong, at the apices of the lobes of the segments. Indusium the same shape as the frond, formed of its reflexed margin.

Lonchitis. Sori marginal, in the sinuses of the frond, reniform or elongated. Indusium shaped like the sorus, membranous, formed of the frond.

Hypolepis. Sori marginal, in the sinuses of the frond, small, subglobose, uniform. Indusium formed of the reflexed margin, membranous.

Cheilanthes. Sori terminal or nearly so on the veins, at first small, subglobose, afterwards confluent. Indusium formed from the changed reflexed margin, roundish, or confluent, not quite continuous.

Cassebeera. Sori terminal on the veins, globose or oblong, not reaching beyond the branches of a single vein. Indusium inserted within the margin, and separate from it, shaped like the sorus.

Onychium. Sori on a continuous linear receptacle, connecting the apices of several veins. Indusium parallel with the margin of the segments, linear, opposite, pressed over the sori, the edge nearly or quite reaching the midrib.

Llavea. Sori linear, occupying the whole length of the changed pod-like segments of the upper part of the frond. Indusium the same shape, rolled over and concealing them.

Cryptogramma. Sterile and fertile fronds usually different, from the same root; sori terminal on the veins, at first subglobose, then confluent, the continuous indusium formed of the changed inrolled margin of the frond.

Pellæa. Sori intramarginal, terminal on the veins, at first dot-like or decurrent on the veins, then running into a line. Indusium formed of the more or less changed edge of the frond, continuous, sometimes very narrow.

Pteris. Sori marginal, linear, continuous, occupying a slender filiform receptacle in the axis of the indusium. Indusium the shape of the sorus, usually membranous, at first covering it, then spreading.

Ceratopteris. Sori placed on two or three veins which run longitudinally down the frond, and which are nearly parallel with both the edge and the midrib. Indusium formed of the reflexed margin of the frond, those of the two sides meeting at the midrib.

Lomaria. Sori linear, continuous, longitudinal, and occupying the space between the midrib and the edge. Indusium membranous, formed of the revolute margin of the frond.

PTERIS, Linn.—A genus of Pterideæ (Polypodiaceous Ferns), represented by one indigenous species, *Pteris aquilina*, the common Brake Fern; numerous tropical species. (Hooker, *Syn.* 153.)

Fig. 612.

Pteris,
A pinnule with marginal indusiate sori.
Magnified 10 diameters.

PTEROCOM'MA, Buckt.—A genus of Aphidæ. *P. pilosa*, on willow-twigs. (Buckton, *Aphidæ*, *Ray Soc.* ii. 142.)

PTERODI'NA, Ehr.—A genus of Rotatoria, of the family Brachionæa.

Char. Eyes two, frontal; foot simply styliform. At the end of the tail-like foot is a suctorial disk; jaws with the teeth either arranged in a row, or two teeth only in each.

Three species; two freshwater, one marine.

P. patina (Pl. 44. fig. 20). Testula membranous, orbicular, crystalline, roughish near the broad margin; a depression present between the rotatory lobes. Freshwater; length 1-120″.

Bibl. Ehrenberg, *Infus.* 516; Pritchard, *Inf.* 711.

PTEROP'TUS, Dufour.—A genus of Acarina (Arachnida), family Gamasea.

Char. Body depressed; last joint of palpi longest; legs stout, with short joints.

P. vespertilionis (Pl. 6. fig. 39). Found

upon bats. Several species have been described.

Bibl. Gervais, *Walckenaer's Aptères*, iii. 227; Dufour, *Ann. Sc. N.* xvi. 98, xxv. 9; Koch, *Deutschl. Crustac.*; Murray, *Ec. Ent.* 175.

PTERYG'IUM, Nyl.—A genus of Collemaceous Lichens. 2 species, on calcareous rocks. (Leighton, *Lichen Fl.* 12.)

PTERYGO'NIUM, Sw.—A genus of Mosses. See Neckera.

PTILID'IUM, Nees.—A genus of Jungermanniæ (Hepaticæ), containing one elegant British species, *P. ciliare*, frequent on heaths and rocks in subalpine districts, but rarely found in fruit.

Bibl. Hooker, *Br. Fl.* ii. 126; *Br. Jung.* pl. 65; Ekart, *Jung.* pl. 5. fig. 36.

PTILO'TA, Ag.—A genus of Ceramiaceæ (Florideous Algæ), with flat feathery fronds a few inches high; of a deep red colour, growing on *Laminariæ* or *Fuci*, or on rocks between tide-marks. The fructification consists of:—1. clustered roundish *favellæ* containing spores, terminating the ultimate pinnules, and surrounded by an involucre of subulate ramuli, or naked; 2. tetrahedral *tetraspores* on short pedicels fringing the pinnules. Antheridia have not been observed. *P. plumosa* (Pl. 4. fig. 16).

Bibl. Harvey, *Mar. Alg.* 159, pl. 22 A; *Phyc. Br.* pl. 70; Greville, *Alg. Br.* pl. 16; Nägeli, *Algensystem*, pl. 6. figs. 38–42.

PTYCHOG'RAPHA, Nyl.—A genus of Graphidei (Lichenaceous Lichens). 1 sp., on decorticated mountain-ash. (Leighton, *Lich. Fl.* 392.)

PTYCHOS'TOMUM, St.—A genus of Holotrichous Infusoria. Free, ovate, unsymmetrical, mouth ventral. 2 species, in the intestines of Annulata (*Tubifex*), and Mollusca (*Paludina*). (Kent, *Inf.* 541.)

PTYGU'RA, Ehr.—A genus of Rotatoria, of the family Ichthydina.

Char. Eyes none; no hairs upon the body; tail-like foot cylindrical, simply truncate.

Teeth three in each jaw; anus situated at the end of the tail-like foot.

P. melicerta (Pl. 44. fig. 21). Body tereteclavate, turgid in front, hyaline; mouth with two little hook-like horns; cervical process single and smooth. Freshwater; length 1-144″. Ehrenberg questions whether this is not a young form of another genus.

Bibl. Ehrenberg, *Inf.* 387; Hudson, *Mn. M. Jn.* xiv. 165.

PTYXID'IUM, Perty.—A genus of Euchelia. It should probably be included in Leucophrys.

Bibl. Pritchard, *Infusoria*, p. 615.

PUCCIN'IA, Persoon.—A genus of Uredinei (Hypodermous Fungi), containing numerous parasitical species, growing upon the leaves and other herbaceous parts of the higher plants, forming "mildews," and with their Uredinous forms, "rusts" &c. These Fungi have received considerable attention lately from Tulasne, De Bary, and others; and it appears that the genera *Uredo* and others have no distinct existence, but are preparatory forms of *Puccinia* and other genera noticed under Uredinei. In the article Æcidium we have described the twofold reproductive structures, namely the spermogonia and the perithecia (figs. 6 & 6 *a*, p. 19; Pl. 26. figs. 1–4), producing respectively the spermatia (supposed to have the office of spermatozoids) and the spores. In *Puccinia* three forms of reproductive organs occur: first, spermogonia analogous to those of *Æcidium*; then the forms called Uredines (chiefly of the supposed genus *Trichobasis*), producing globular unilocular bodies, shortly stalked, and with transparent walls, but with yellow or orange-coloured contents; and lastly the true *Puccinæ*, containing bilocular spores borne on short stalks, and having a dark-brown integument. The latter present remarkable phenomena in germination, which may be best observed in those which sprout without becoming detached from the matrix, such as *P. graminis*, which however remain quiescent until the spring following their development, while *P. Glechomæ*, *Buxi*, *Dianthi*, and others germinate in the same summer. The bilocular spores have each one pore (analogous to the pores of Pollen-grains), from which extends a filamentous process, ultimately giving rise to four short processes, each terminating in a pointed process bearing a *sporidium*, of more or less curved elliptical form. About the time when these fall off, the filament bearing the four processes becomes divided by septa into four chambers, but then appears to die. The sporidia germinate and produce a filament, which, instead of becoming the basis of a mycelium, reproduces a sporidium smaller than the first. More is said respecting these remarkable organisms under the head of Uredinei.

The *Puccinæ* present the following general characters:—The *spermogonia* rare, scattered on either face of the infested leaf,

with an immersed, ostiolate peridiole, bearing long cilia at the mouth; pale, orange, or blackish in colour. The *Uredinous* fruits are scattered or grouped in circles, devoid of a proper peridium, but surrounded sometimes by thickish cylindrical paraphyses, very rarely connected below into a membrane, forming a kind of ciliated peridium; the *stylospores* are round and mostly spinulose, with three or four equidistant pores. The *Puccineous* fruits are also scattered or grouped in circles, sometimes containing only their proper spores, sometimes with Uredinous spores intermixed, destitute of a proper peridium, but, like the *Uredines*, having sometimes a false envelope formed of confluent paraphyses; their *spores*, forming the chief distinctive character of the genus, are *bilocular*, oblong or globose, rounded-obtuse or acuminate at the apex, smooth or spinulose, the upper loculus with a pore at its summit, the lower with a pore at the upper end of one side (next the septum).

These plants occur commonly on the Grasses and many other herbaceous plants, often changing colour during the summer, being yellow or orange when the Uredinous spores are ripe, and afterwards blackish when the Puccineous form is mature.

The species are very numerous; but some of those formerly included under this name are now removed to other genera, such as *Uromyces*, *Triphragmium*, &c. (See Uredinei.) *P. graminis* is common on corn and other grasses (*Mildew*); among the other frequent species are *P. Caricis*, *Polygonorum*, *Menthæ*, *Anemones*, *Buxi*, &c. Robin describes a *Puccinia*, apparently on the authority of Ardsten, a Swedish physician, found upon the human head in Favus. From his description it appears to be a true *Puccinia*, and should hold its place (*P. Favi*, Ardst.) among the species. But what is more remarkable, it occurs together with *Achorion Schœnleinii*, the latter presenting itself as a constituent of the cups or crusts, while the *Puccinia* occurs afterwards on the desquamations of the epidermis.

Bibl. Berk. *Br. Fl.* ii. pt. 2. 363; *Ann. N. H.* vi. 439; *ibid.* 2. v. 462, xiii. 461; Tulasne, *Ann. Sc. Nat.* 3. vii. 12; *ibid.* 4. ii. 77, 138 & 182; Léveillé, *ibid.* 3. viii. 369; De Bary, *Brandpilze*, 36; Fries, *Sum. Veg.* 513; Robin, *Végét. Parasit.* 2. 613; Bagnis, *Jn. Mic. Soc.* 1878, i. 27.

PULEX, Linn. (Flea).—A genus of Insects, of the order Siphonaptera (Suctoria or Aphaniptera), and family Pulicidæ.

Char. As there are only the single family and genus in the order, the characters of the latter are distinctive.

Head small (Pl. 35. fig. 9), compressed, rounded above, truncate in front, in some species with an inferior pectinate fringe of blackish-brown teeth; eyes one on each side, round, simple, smooth; behind each eye is a cavity or depression, at the bottom of which the antennæ are attached; antennæ (figs. 9 *a*, 12) four-jointed, their form varying in the different species, the third joint very minute, and forming the cup-shaped base of the terminal joint or piece, which in some species is furnished with numerous transverse incisions, representing as many distinct joints; in some the antennæ extend out of the depression, and are carried erect.

Oral appendages (Pl. 35. fig. 9 *e*) composed of several parts: 1. (Pl. 33. figs. 32 *d*, 33 *d*) The uppermost is single, and consists of a thin, flattened seta, coarsely toothed on the upper surface, and traversed throughout its entire length by a canal, upon the walls of which a very slender trachea runs, and from which very minute canals, terminating at the end of the little teeth, are given off. This is the suctorial organ, and perhaps corresponds to the labrum, but is sometimes regarded as the lingua or ligula. 2. (figs. 32 *f*, 33 *f*) Two quadrangular, narrow, and elongated plates, each furnished with longitudinal ribs, and with fine teeth; these are the lancets or scalpella, and correspond to the mandibles. 3. (Pl. 33. fig. 32 *g*) Two somewhat triangular or leaf-like plates, the maxillæ; to which are attached—4. (Pl. 33. fig. 32 *h*; Pl. 35. fig. 9 *d*) Two nearly cylindrical four-jointed maxillary palpi. 5. (Pl. 33. fig. 32 *k*; fig. 33 *k*) Two labial palpi, in the form of sheaths, four-jointed, thickened at the back and membranous at the margin; these palpi arise from near the apex of—6. (Pl. 33. fig. 33 *l*) A small membranous labium, with the still smaller mentum (Pl. 33. fig. 33 *m*) at its base.

Thorax composed of three segments, each consisting of an upper (Pl. 35. fig. 9, *c*), and a lower piece *f f*; from the lower arise the corresponding legs. The two posterior segments of the thorax are each furnished with a pair of plates, the hindermost of which is longest, and nearly covers the sides of the first and part of the second abdominal segment (fig. 9, behind *f*, *f*); these represent rudimentary wings.

The legs are large, especially the hinder

ones, and adapted for leaping. The first joint or coxa (*g*) is very thick; the second or trochanter (*k*) is very small; next come the femur (*i*), the tibia (*k*), and lastly the five-jointed tarsus (*l*), which is terminated by two curved and denticulate claws, with a lobe or heel at the base.

The abdomen of the female has nine distinct rings, the first seven of which are each furnished with a pair of stigmata (*a*), and consist of horny arches with membranous margins. The eighth arch, which has no membranous margin, is strengthened by a horny band furnished with fine hairs, to protect the orifice of the last stigma. The ninth and last segment, called the pygidium (fig. 9× and Pl. 1. fig. 13), is somewhat kidney-shaped or two-lobed, folded on the dorsum, and exhibits twenty-five to twenty-eight stiff and longish bristles, implanted in the centre of as many disk-like areolæ, each of which is ornamented with a ring of rectangular or somewhat cuneate rays. The portions of the pygidium between the areolæ are studded with minute spines. The end of the abdomen in the female (Pl. 35. fig. 9) is more rounded or ovate than that of the male (fig. 13), which is somewhat turned upwards.

In some species the segments of the thorax and abdomen are furnished with a posterior pectinate fringe.

The alimentary canal is short and straight; the stomach cylindrical; the small intestine as long as the stomach, and the large intestine short. Four short and broad Malpighian vessels open into the lower orifice of the stomach; and the ducts of two round salivary vesicles unite to a single canal ascending in a coiled form on each side of the œsophagus towards the mouth.

The eggs of the flea are white, elongated, and viscid outside. The larvæ have no legs; they are elongated, resembling minute worms, and very active, coiling themselves into a circle or spiral, and serpentine in their movements. The head is scaly, without eyes, and supporting two very minute antennæ; the body has thirteen segments, with small tufts of hairs, and at the end of the last are two little hooks.

The species are numerous (twenty-five, Gervais); but their characters are not well defined. One species (*P. terrestris*) is said to exist under brush-wood; and one (*P. Boleti*) in *Boleti*.

P. irritans, human flea. Pitch-brown; head shining, smooth, pectinate fringe absent; legs pale; femora of posterior legs with hairs inside; second joint of the tarsi of the anterior pair of legs and first joint of posterior tarsi longest. Tarsal joints, in respective order of greatest length: anterior, 2, 5, 1, 3, 4; posterior, 1, 5, 2, 3, 4 (Bouché). We have not been able to find a flea with the above relative length of the joints of the anterior tarsi.

P. felis, cat's flea (*P. canis*, Bouché; Pl. 35. fig. 9). Pale pitch-brown; head naked, shining, smooth, with delicate scattered dots; coxæ and femora almost naked; fifth joint of anterior tarsi and first joint of posterior tarsi longest. Tarsal joints: anterior, 5, 2, 1, 3, 4; posterior, 1, 2, 5, 3, 4.

P. canis or *serraticeps*, flea of dog and fox (*P. felis*, Bouché; Pl. 35. fig. 10, head). Pale pitch-brown; head shining, smooth, punctate behind; lower part of head and prothorax with a pectinate fringe; posterior tibiæ much expanded at the end; fifth joint of anterior and first of posterior tarsi longest. Tarsi: anterior, 5, 2, 1, 3, 4; posterior, 1, 5, 2, 3, 4.

P. gallinæ, fowl's flea. Pitch-brown, with shining, smooth, elongated head; prothorax with a pectinate fringe; first joint of all the tarsi longest. Tarsi: anterior and posterior, 1, 2, 5, 3, 4.

P. martis, flea of the marten and dog. Postero-inferior margin of head and prothorax with pectinate fringe; tarsi as in *P. canis*.

P. sciuri, flea of the squirrel. Head naked; pectinate fringe on prothorax, none upon the abdomen. Tarsi: anterior, 1, 5, 2, 3, 4; posterior, 1, 2, 5, 3, 4.

P. erinacei, flea of hedgehog. Head naked, mesothorax with a fringe. Tarsi: anterior, 5, 2, 1, 3, 4; posterior, 1, 2, 5, 3, 4.

P. talpæ, Curtis, flea of mole (Pl. 35. fig. 24).

P. columbæ, pigeon's flea. Prothorax with pectinate fringe, none upon the abdomen; antennæ of male erect, those of the female lying in the depression.

P. penetrans (*Rhynchoprion*), the chigoe or jigger. The females burrow in the skin of the feet; and the ova, undergoing development, enlarge the parent-abdomen to the size of a pea, causing severe inflammation, &c. Rostrum very long. Tropical.

P. vespertilionis, flea of the bat (Pl. 35. fig. 11, head); the first seven segments of the abdomen with pectinate fringes.

P. pipistrellæ. The two first and the seventh segments only with teeth.

BIBL. Westwood, *Intr.* ii. 489; Bouché, *Nov. Act.* 1835, xvii. 501; Dugès, *Ann. Sc. N.* 1832, xxvii. 165; Gervais, *Walckenaer's Apt.* iii. 362; Denny, *Ann. N. H.* 1843, xii. 315; Landois, *An. d. Hunde-Flohs*, 1867; Furlong, *Mn. Mic. Jn.* 1872, 263; Mégnin, *Paras.* 60; Taschenberg, *D. Flöhe*, 1880.

PULLE'NIA, Parker & Jones.—A minute, globose, glassy, nautiloid Foraminifer, near *Globigerina*; showing usually 4 or 5 chambers and a transverse slit-like aperture; an isomorph of *Nonionina*. Recent and fossil.

BIBL. Carpenter, *Introd. For.* 184.

PULVINULI'NA, Parker & Jones.—One of the typical *Rotalidæ*. Shell with 7–30 cells; dense and delicately tubuliferous, often limbate, sometimes prickly, granulate, and stellate; usually biconvex (*P. repanda*, Pl. 24. fig. 16); sometimes outspread, and vermiculate (*P. vermicularis*, Pl. 24. fig. 11); septa single, little trace of canal-system; aperture large, arched or notched; septal face often coarsely perforated. Very numerous species, recent and fossil.

BIBL. Carpenter, *For.* 310; Parker and Jones, *Phil. Tr.* clv. 390.

PUNCTA'RIA, Greville.—A genus of Punctariaceæ (Fucoid Algæ), containing three (one doubtful) British species, *P. latifolia*, *plantaginea*, and *tenuissima*, growing on rocks and stones, consisting of membranous, olive or brown, ribless fronds, 4 to 12″ long, 1 to 3″ broad, having a shield-like organ of attachment at the base. The fructification consists of *sori* scattered all over the fronds in minute distinct dots, composed of roundish sporanges (producing zoospores) intermixed with paraphyses; these sporanges are called *spores* in most works.

BIBL. Harvey, *Mar. Alg.* 41 and *Phyc. Brit.*; Greville, *Alg. Brit.* pl. 9.

PUNCTARIACEÆ.—A family of Fucoideæ. Root a minute naked disk; frond cylindrical, or flat, unbranched, cellular, with ovate *sporanges* intermixed with jointed threads in groups on the surface. *British Genera*:

Punctaria. Frond flat and leaf-like. *Sporanges* scattered or in sori.

Asperococcus. Frond membranous, tubular, either cylindrical or compressed. *Sporanges* in dot-like sori.

Litosiphon. Frond cartilaginous, filiform, subsolid. *Sporanges* scattered, almost solitary.

PUS.—Popularly known as "matter;" one of the products of inflammatory exudation.

Its general properties are too well known to require description. Pus consists of an albuminous liquid, containing a number of minute corpuscles in suspension. These consist of molecules and granules composed of proteine compounds, fat or the earthy phosphates, globules of fat of very various sizes, and the proper pus-corpuscles or leucocytes. Pus-corpuscles (Pl. 38. fig. 4) are spherical, from 1-2500 to 1-3500″ in diameter; presenting a granular appearance on the surface, and containing a number of larger or smaller granules and a small quantity of liquid. They are undistinguishable from the white corpuscles of the blood, and may be considered as *leucocytes*. They possess as protoplasmic masses the power of spontaneous movement; and migrate in the tissues. They multiply by division. When treated with acetic acid, they swell up, and the granules become excessively transparent, and ultimately vanish (Pl. 38. fig. 5), leaving from one to five, generally two or three, round or oval nuclei, which mostly present a dark margin and light centre, giving them a cupped appearance, indicating a diminution of refractive power in the centre. The cupped centre is sometimes seen in the nuclei without acetic acid, after the action of water only.

In the pus of chronic abscesses, unhealthy ulcers, &c. the corpuscles are often few, deformed and mixed with numerous granules of proteine, fatty and calcareous matters, crystals of cholesterine, of the ammoniophosphate of magnesia, and sometimes monads and vibrios; exudation-corpuscles are occasionally present also.

Pyoid corpuscles. — Under this term Lebert describes a modification of pus-corpuscles, consisting of a tolerably transparent envelope, enclosing from eight to ten or more small globules (Pl. 38. fig. 6). Acetic acid does not alter them, or at most only renders them slightly more transparent. The small globules are composed of a proteine-compound; for they are soluble in potash.

BIBL. That of CHEMISTRY, Animal; and Lebert, *Phys. Path.*; Rindfleisch, *Path. Hist.*; Green, *Morb. Anat.*

See INFLAMMATION.

PUSTULIP'ORA, Blainville.—A genus

of Infundibulate Cyclostomatous Polyzoa, family Tubuliporidæ.

Char. Zoary erect, cylindrical; cells half-immersed, arranged on all sides; orifices prominent.

Two British species—*P. proboscidea*, and *P. deflexa*. The latter common on shells from deep water.

Bibl. Johnston, *Br. Zooph.* 278; Gosse, *Mar. Zool.* ii. 8.

PYCNIDIA.—A term applied to the receptacles enclosing *stylospores* in the Lichens and Fungi.

PYCNOG'ONUM.—A genus of Podosomata, Sea Spiders, which are usually placed amongst the Crustacea, but by some authors amongst the Arachnida. They have no special respiratory organs, and only four pairs of legs. They sprawl over seaweed, and hide under stones. There is a pair of chelate mandibles.

PYCNOPHY'CUS, Kütz.—A genus of Fucaceæ (Fucoid Algæ), containing one British species, *P.* (Fucus) *tuberculatus*; removed from *Fucus* on account of its cylindrical frond, the compact cellular substance of the receptacles, and the ramified fibrous pseudo-root. The fructifications, formed at the ends of the dichotomous lobes of the frond, are elongate, cylindrical, more or less tuberculated, and with numerous pores opening from conceptacles containing *spore-sacs* and *antheridia* (together), resembling in general those of *Fucus*. The spore-sacs are collected at the bottom of the conceptacles, the antheridia at the upper part. See Fucus.

Bibl. Harvey, *Mar. Alg.* 18; *Phyc. Br.* 89; Decaisne and Thuret, *Ann. Sc. N.* 3. iii. 5; Thuret, *ibid.* xvi. 10.

PYGID'IUM.—The last segment of the abdomen of certain insects. It exhibits a curious structure in *Pulex* (p. 647); the same is stated to occur also in *Chrysopa*, the lace-winged fly, the locust &c. (Davis, *Jn. Mic. Soc.* 1879, ii. 252.)

PYRAMID'IUM, Bridel.—A genus of Funariaceæ (Acrocarpous Mosses), allied to *Funaria* in habit, but differing in important points.

Pyramidium tetragonum, Brid. = *Gymnostomum tetragonum*, Schwägr.

PYRENID'IUM, Nyl.—A genus of Collemaceous Lichens.

Char. Thallus minute, stellato-divided; apothecia pyrenocarpous, verrucarioid. *P. actinellum*; on chalk. (Leighton, *Lich. Fl.* 36.)

PYRENODEI.—A series of Lichenacei.

Char. Fructification in closed receptacles.

Bibl. Leighton, *Lich. Flora*, p. 2.

PYRENOMYCE'TES.—That portion of the Ascomycetous and Coniomycetous Fungi having a closed, nuclear fruit; standing opposed to the Discomycetes, with open fruits, like the Angiocarpous and Gymnocarpous Lichens. Now sunk in Sphæriacei.

PYRENOP'SIS, Nyl.—A genus of Collemaceous Lichens. 8 species; on rocks. (Leighton, *Lich. Flora*, 14.)

PYRENO'THEA, Fries.—A genus of Limboriese (Angiocarpous Lichens), containing a number of species separated from *Verrucaria*, on account of the spores being free in the perithecia and not developed in thecæ. The bodies taken for spores, however, are spermatia contained in spermogonia, the sporiferous perithecia being apparently unknown (see Lichens).

Bibl. Leighton, *Ang. Lichens*, 65; Tulasne, *Ann. Sc. N.* 3. xviii. 217.

PYRSONE'MA, Leidy.—A genus of Holotrichous Infusoria. Body fusiform, with a cord-like longitudinal undulating border. *P. vertens*, in the intestine of the white ant (*Termes*); length 1-200″. (Kent, *Inf.* 554.)

PYRULI'NA, D'Orb.—A neat acuto-pyriform *Polymorphina*. Fossil in the Chalk, and German Tertiaries.

Bibl. D'Orbigny, *Mém. Soc. Géol. Fr.* iv. 43; Brady, Parker and Jones, *Linn. Tr.* xxvii. 219.

PYTHIUM, Pringsheim.—A supposed genus of parasitic Unicellular Algæ, the true nature of which, however, is yet doubtful.

P. entophytum (Pl. 5. fig. 8) occurs in this country in diseased cells of Confervoid Algæ. It consists of minute flask-shaped bodies, taking the place of the proper cell-contents, finally pushing the neck-like portion through the wall of the cells, outside of which it bursts and discharges active (?) molecules, which Pringsheim regards as gonidia. *P. monospermum* grows upon insects in water, in the manner of *Achlya*; and he refers this genus to the family Saprolegnieæ.

Bibl. Pringsheim, *Jahrb. wiss. Bot.* i. 289; Carter, *Ann. N. H.* 2. xvii. 101; Henfrey, *Tr. Mic. Soc.* New Series, vii. 25; Currey, *Mic. Jn.* v. 211; Rabenht. *Alg.* iii. 276.

PYXIC'OLA, Kt.—A genus of Peritrichous Infusoria; like *Cothurnia*, but with

an operculum. Several species; fresh and salt water. (Kent, *Inf.* 725.)

PYXIDIC'ULA, Ehr.—A genus of Diatomaceæ.

Char. Frustules single, free or sessile; valves circular, convex, hoop absent.

Numerous species have been described—one fr. wat., one marine, the remainder fossil, found in America.

Rabenhorst reduces the species to *P. major*, *adriatica*, and a doubtful form, *P. Naegelii*.

P. major (Pl. 25. fig. 13). Valves conical, regularly punctate. Diameter 1-420"; freshwater.

P. adriatica. Fr. sessile; valves near y hemispherical, free from markings (ord. ill). Upon marine Algæ. Diam. 1-600".

P. minor=Cyclotella operculata.

The bodies represented in Pl. 25. fig. 12, found in flint, have been described as *P. globator*, Pritch. (not *P. globosus*, Ehr.); they do not, however, appear to belong to the Diatomaceæ.

Kützing places *Stephanopyxis* and *Xanthiopyxis* here.

Bibl. Ehr. *Inf.* 165, and *Ber. Berl. Ak.* 1844 & 1845; Kütz. *Bacill.* 51, and *Sp. Alg.* 21; Pritchard, *Inf.* 432.

PYXID'IUM, Kt.—Like *Operularia*, but solitary. Two species; freshwater; on Entomostraca and Confervæ. (Kent, *Inf.* 666.)

PYXILLA, Grev.—A genus of Diatomaceæ.

Bibl. Grev. *Mic. Trans.* 1865, 2.

Q.

QUARTZ. See Rocks.

QUILL.—The quill of feathers possesses considerable polarizing power; the coloured bands, however, are so broad that they are better seen with the naked eye.

See Feathers.

QUININE. See Alkaloids.

Iodo-disulphate, sulphate of iodo-quinine, Herapathite.—This remarkable salt is prepared by dissolving disulphate of quinine in strong acetic acid, warming the solution, dropping into it an alcoholic solution of iodine carefully in small quantities at a time, and placing the mixture aside for some hours, when the crystals separate.

They dissolve in the heated mother-liquor, also in hot alcohol, being again deposited on cooling; but they are not soluble in cold alcohol or ether.

They are so easily decomposed and altered, that they are with difficulty mounted. This may, however, be effected by cautiously neutralizing the excess of acid in the mother-liquor by solution of ammonia, taking care not to precipitate the excess of the disulphate of quinine; a portion of the liquid containing the crystals is then transferred to a slide, the liquid removed with blotting-paper, and the crystals dried in a current of cold air. They are then mounted in Canada balsam rendered thin with ether, heat being avoided.

The crystals are of a pale olive-green colour (Pl. 11. fig. 17), and possess a more intense polarizing power than any other known substance. The play of colours presented when they are rolling over each other whilst contained in a watch-glass, forms a very beautiful sight, the colours varying according to the relative positions of the crystals to each other; and when the latter cross each other at a right angle, complete blackness is produced.

Herapath, who discovered this beautiful salt, has described a method of making crystals of sufficient size to replace tourmalines or Nicol's prisms. The ingredients are:—as pure disulphate of quinine as can be obtained, that from Howard and Kent being best; strong acetic acid, of sp. gr. 1·042; proof spirit composed of equal bulks of rectified spirit of sp. gr. ·837 and distilled water; and tincture of iodine, made by dissolving 40 grains of iodine in 1 oz. of rectified spirit. The proportions are:

Disulphate of quinine..	50 grains.
Acetic acid	2 fluid ounces.
Proof spirit	2 fluid ounces.
Tincture of iodine	50 drops.

The disulphate of quinine is dissolved in the acetic acid mixed with the spirit, the solution heated to 130° F., and the tincture of iodine immediately added in drops, the mixture being constantly agitated.

The compound should be prepared in a wide-mouthed Florence flask; and the temperature should be maintained for a little time after the addition of the iodine, so that the solution may become perfectly clear, and of a dark sherry-colour. It should then be set aside to crystallize in a room of a uniform temperature of 45° to 50° F., and kept from vibration. The latter may be effected by suspending the flask by the neck with strong string, attaching this to a horizontal cord stretching across the room from one wall to the other; or placing the flask on a steady support, lying upon a pillow. The large crystalline plates form upon the

surface of the liquid, where they are allowed to remain for twelve to twenty-four hours, until they have acquired sufficient thickness. The flask is then carefully removed without shaking, and rested upon a gallipot. A circular cover is next fastened by its edge to the end of a glass rod with a little wax or marine glue, and passed beneath one of the crystalline films, the adherent mother-liquor removed with blotting-paper, and the film allowed to dry in a room at a temperature of 45° to 50° F. The cover and film are then placed under a small bell-glass, with a watch-glass containing a few drops of tincture of iodine. The time required for the iodizing may be about three hours at 50° F., or less if the temperature be higher.

The film is then covered with a solution of Canada balsam in ether, saturated with iodine by warming with a few crystals of this substance, and allowing it to cool.

Other films are removed and mounted in the same manner. Should the films not separate from the original liquid at the end of six hours, this must be heated with a spirit-lamp until the deposited crystals are dissolved, a little spirit and a few drops more tincture of iodine added, and the liquid again set aside.

If the film appear black when removed on the cover, it is crossed by an adherent or interposed crystal, which must be carefully removed.

These crystals are sold ready mounted, and may be purchased at a very small cost.

Herapath proposes the production of the crystal of the quinine-salt as a very delicate test for the presence of quinine. A test-liquid is first made with 3 drachms of acetic acid, 1 drachm of rectified spirit, and 6 drops of dilute sulphuric acid. A drop of this is placed upon a slide and the alkaloid added, and, when it is dissolved, a very minute quantity of tincture of iodine added; after a time the salt separates in little rosettes.

Bibl. Herapath, *Phil. Mag.* 1852, iii. 161, iv. 186, and 1853, vi. 171 & 346; Haidinger, *ibid.* 1853, vi. 284.

QUINQUELOCULI'NA, D'Orb.—One of the modifications of *Miliola*, having its chambers aggregated on two opposing faces, as in *Spiroloculina*, but with their edges more extended on the one side than on the other, so that only three chambers are apparent on one side, and *five* on the other. Numerous *Quinqueloculinæ* occur recent and fossil. *Q. seminulum* (Pl. 23. fig. 5) is common in the European seas. *Q. Brongniartii* (fig. 6), having delicate striæ, is not uncommon in warmer seas.

Bibl. Williamson, *Foram.* 85 (*Miliolina*); Carpenter, *For.* 78.

R.

RACO'DIUM. See Antennaria.

RACOMIT'RIUM = Trichostomum pt.

RADIOLA'RIA, Müller.—An order of Rhizopoda, including the Polycystina, Acanthometrina, Thalassicollida, and Actinophryina. They possess a siliceous test or siliceous spicules, a central capsule and peculiar yellow cells, and are provided with long, protruding, radiating pseudopodia which occasionally form meshes. See the Families and Rhizopoda.

Bibl. Haeckel, *Radiolarien*, 1862; Greef, *Arch. mik. An.* 1869, 1875.

RAD'ULA, Dumort.—A genus of Jungermannieæ (Hepaticæ), containing one British species, *R. complanata* (fig. 613),

Fig. 613.

Radula complanata.
Leafy shoot with an immature and a burst capsule.
Magnified 5 diameters.

common upon the trunks of trees, everywhere, forming orbicular pale-green patches closely appressed to the bark.

Bibl. Hook. *Br. Jung.* pl. 81; *Br. Flor.* ii. pt. 1. p. 120; Ekart, *Syn. Jung.* pl. 4. fig. 31; Endlicher, *Gen. Plant.*, Supp. 1. No. 472. 13; Leitgeb, *Ber. Wien. Ak.* 1871.

RAD'ULUM.—A genus of Hydnei (Hymenomycetous Fungi), consisting of a few species with irregular compressed teeth or rude irregular tubercles. *R. orbiculare* is not infrequent on fallen branches of birch and other trees, assuming various forms.

Bibl. Fr. *El.* 148; Berk. *Outl.* 263; Cooke, *Handb.* 304.

RALF'SIA, Berk.—A genus of Myrione-

maceæ (Fucoid Algæ), containing one British species, *R. verrucosa* (*R. deusta*, Berk.), forming dark-brown Lichen-like patches, 1 to 6″ in diameter, on rocks between tidemarks. The fronds are at first orbicular and concentrically zoned; they are composed of densely packed, vertical, simple, jointed filaments. The fruit is formed in wart-like patches, and consists of obovate sporanges attached to the bases of vertical filaments.

Bibl. Harvey, *Mar. Alg.* 49.

RAMALINA, Ach.—A genus of Ramaloidei (Lichenaceous Lichens), containing 13 British species, of shrubby habit, mostly growing upon the trunks of trees, bearing orbicular-peltate apothecia, nearly of the same colour as the thallus. *R. fraxinea*, *fastigiata*, and *farinacea* are common.

Bibl. Hook. *Br. Fl.* ii. pt. 1. 228; Tulasne, *Ann. Sc. Nat.* 3. xvii. 192.

RAMULI'NA, R. Jones.—A tubular branching Hyaline Foraminifer, swollen here and there into chambers, whence the branches or stoloniferous tubes proceed at varying angles to other such chambers. *R. aculeata*, D'Orb., *R. lævis*, and *brachiata*, Jones, are known from the Chalk; *R. globulifera*, Brady, has a wide distribution in the Atlantic and Pacific.

Bibl. Rupert Jones, *Proc. Belfast N. F. Club*, 1875, n. ser. i. 88; Brady, *Jn. Mic. Soc.* n. ser. xix. 272.

RA'NA, Linn. See Frog.

RAPH'IDES.—This name was first applied to the minute needle-shaped crystals occurring in great abundance in the tissues of many plants; but it is now generally applied to all the crystalline formations contained in vegetable cells. The crystals are either solitary or grouped; and sometimes the groups are formed on a peculiar stalked matrix projecting into the cavity of enlarged cells, forming the organs called *cystoliths*.

There are few plants of the higher classes which do not contain raphides: they are very abundant in the herbaceous structures of the Monocotyledons generally, and especially those of the Araceæ, Musaceæ, Liliaceæ, &c.; they also abound in the Polygonaceæ, Cactaceæ, Euphorbiaceæ, Urticaceæ, &c., among the Dicotyledons. They are usually found only in the interior of the cavities of cells, but in some cases they occur in the intercellular cavities, or in the cell-walls. They may occur in almost any part, but are found most extensively in the stems of herbaceous plants (Monocotyledons in general and Cactaceæ); they also occur in the bark and pith of many woody plants (lime, vine); leaves likewise frequently contain them in vast numbers (Araceæ, Musaceæ, Liliaceæ, Iridaceæ, Polygonaceæ); also sepals (Orchidaceæ, Geraniaceæ); in the rhubarbs, and also in Umbelliferæ, they occur extensively in the roots, for instance in the carrot; and they abound in autumn in the base of the bulbs of the onion and other Liliaceæ. Raphides are often very readily discovered and clearly seen in tissues, by the aid of the polarizing apparatus.

The form of the needle-shaped raphides is usually that of a square prism with pyramidal ends. These ordinarily occur lying parallel in bundles (fig. 614); another common form is that of rectangular or rhombic prisms with oblique or pyramidal ends; the smaller of these often present themselves in groups radiating from a centre (fig. 615). Prisms of similar or of six-sided forms, octahedra, rhombs, &c. also occur singly or few together (Pl. 48. fig. 28), the larger ones sometimes nearly filling the cavity of

Fig. 614.

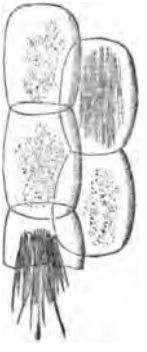


Fig. 615.

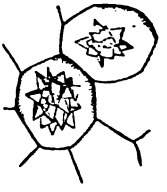


Fig. 614. Parenchymatous cells of the stem of Rumex, containing bundles of raphides. Magnified 400 diams.
Fig. 615. Parenchymatous cells of the stem of Beta, with groups of raphides (Sphæraphides). Magnified 400 diams.

the cells in which they lie. Rhombic crystals of oxalate of lime occur in the parenchymatous cells surrounding the vascular bundles in the bracts of *Medicago trigonella*; and Gulliver has shown the crystal in each cell of the testa of the elm. The cells containing the bundles of acicular raphides in the Araceæ also contain a viscid sap, which causes them to burst, through endosmose, when placed in water, and dis-

charge the crystals. Turpin erroneously described these as organs of a special nature, under the name of *Biforines*.

Raphides most frequently consist of oxalate of lime, especially in the Cactaceæ, Polygonaceæ, &c.; carbonate of lime seems to stand next in the order of frequency, mostly in the form of granules, only recognizable under polarized light with the crossed nicols; then sulphate and phosphate of lime. Their composition may be ascertained by the appropriate tests for these salts. It is sometimes difficult to determine the form accurately, on account of the small size; it is found advantageous to mount well-cleaned and partly crushed crystals in Canada balsam, also to view them rolling over in alcohol (Intr. p. xxxiii).

The peculiar crystalline structures called *cystoliths*, occur most abundantly in the families of the Urticaceæ (including Moreæ) and the Acanthaceæ. They ordinarily consist of a stalked, clavate, and globose, or irregular linear body, suspended in a greatly enlarged cell, most frequently situated beneath the epidermis of the leaf (Pl. 48. figs. 26, 27); but they also occur in deeper-seated regions. Their nature and development have been followed by several observers; and they are found to consist of a cellulose matrix with carbonate of lime crystallized in a kind of efflorescence upon the surface. They appear to originate by a little papilla or column of secondary deposit at the upper end of the cell, which increases by successive concentric layers of cellulose applied on the lower surface, leaving a short stalk-like portion which remains uncovered and also free from the crystals which gradually sprout out from the thickened head. The crystals may be removed by the action of acid; and then the matrix assumes a blue colour with sulphuric acid and iodine. Payen imagined the thicker portion incrusted by the crystals to be composed of numerous cellules, each producing a crystal: this is erroneous. The *cystoliths* vary in form: the clavate kinds may be best observed in *Ficus elastica* (Pl. 48. fig. 27) and other species, in vertical sections of the leaf; globular forms are found in *Parietaria officinalis* (fig. 26) and the Hop; in species of *Pilea* they are linear or crescentic, and suspended by the convex edge.

Bibl. Turpin, *Ann. Sc. Nat.* 2. vi. 5; Dyer, *Qu. Mic. Jn.* 1872, 288; Quekett, *Tr. Mic. Soc.* new ser. i. 20; Gulliver, *Sci. Gossip*, 1873; *Ann. N. H.* 1865; *Qu. Mic. Jn.* 1866, 1869, 1873; *M. M. Jn.* x. 259, xviii. 143; Lankester, *Q. M. J.* 1863, 243; Urban, *Bot. Zeit.* 1873, 266; Sanio, *Monatsb. Berl. Ak.* 1857; Hanstein, *ibid.* 1859; Holzner, *Flora*, 1864; Hilgers, Pringsheim's *Jahrb.* vi. 1867; Rosanoff, *Bot. Zeit.* 1867; Solms-Laubach, *ib.* 1874; Pfitzer, *Flora*, 1872; Sachs, *Bot.* 66.

RAPHIDIOPH'RYS, Archer.—A genus of Rhizopoda.

Char. Bodies green, spherical, aggregate, surrounded by a common investment of cloudy buff-coloured sarcode, containing slender, hyaline, circular, siliceous spicula. Pseudopodia arising from the sarcode between the spicula, long, straight, and very thin; they never coalesce.

Bibl. Archer, *Freshw. Rhiz., Qu. Mic. Jn.* 1869, 1871.

RAPHIDIUM, Ktz.—A genus of Unicellular Algæ. Cells fusiform or cylindrical, acuminate, straight or slightly curved, with green cell-contents. The species are those of *Ankistrodesmus*, *Closterium*, *Micrasterias*, and *Scenedesmus* of other authors.

Rabenhorst regards our *Closterium Griff.* (Pl. 14. figs. 57, 58) as *R. aciculare*.

Bibl. Rabenht. *Fl. Eur. Alg.* iii. 44.

RAPHIG'NATHUS, Dugès.—A genus of Acarina, family Trombidina.

Char. Palpi long, with an indistinct claw; mandibles represented by two short setæ inserted upon a fleshy bulb, concealed by a broad labium; body entire; coxæ contiguous; legs but little attenuated at the ends, anterior longest, last joint longer than the others.

R. ruberrimus (Pl. 6. fig. 35 *a*, labium with mandibles and a palp; *b*, a mandible). Body oval, slightly depressed, smooth, and almost free from hairs, rostrum forming a conical process; eyes two, dark red, one on each side at the anterior part of the body; labium triangular, concave; setæ accompanied by a more slender hair-like process; palpi large, inflated, claw of the 4th joint very short. Found under stones and on plants.

R. hispidus. Form, that of the preceding; body velvety, with two posterior papillæ.

Bibl. Dugès, *Ann. Sc. Nat.* 2. i. 22, ii. 55; Gervais, *Walckenaer's Aptèr.* iii. 172; Murray, *Ec. Ent.* 114.

RAT'TULUS, Lamarck.—A genus of Rotatoria, of the family Hydatinæa.

Char. Eyes two, frontal; tail-like foot simply styliform; neither cirri nor fins present. Teeth indistinct.

R. lunaris (Pl. 44. fig. 22). Eyes distant

from the anterior margin; foot decurved, lunate; freshwater; length 1-288″.

Bibl. Ehrenberg, *Infus.* 448; Pritchard, *Infusoria*, 688.

REBOUIL'LIA, Raddi. — A genus of Marchantieæ (Hepaticæ), founded on *Marchantia hemisphærica*, Linn., characterized by the conical or flattened, 1–5-lobed stalked receptacle (fig. 616), the perigone being adherent to the lobes of the receptacle on the under side, opening by a slit (fig. 617);

Fig. 616. Fig. 617.

Rebouillia hemisphærica.

Female receptacles, with the perigone burst. Fig. 616, seen from above; Fig. 617, from below. Magnified 2 diameters.

perichæte none, and the globose sporange bursting irregularly. The antheridia are imbedded in sessile, crescent-shaped disks. The fronds are rigid, with a well-marked midrib, green above, purple beneath. It grows on moist banks, or by the side of mountain-streams.

Bibl. Hook. *Br. Fl.* ii. pt. 1. 108; Bischoff, *Nova Acta*, xvii. 1001, pl. 69. fig. 1; Endlich. *Gen. Plant.* No. 468.

RECEPTACLES FOR SECRETIONS. See Secreting Organs of Plants.

RED SNOW.—The remarkable phenomenon known under this name has been the subject of very extensive investigation, and it is well known to be the result of the enormous development of a microscopic organism related to *Protococcus* or *Chlamidococcus viridis*. We are inclined to believe that more than one form is comprehended at present under the name of *Protococcus* or *Hæmatococcus nivalis*; for our specimens of Arctic red snow, for which we were indebted to the kindness of R. Brown, appear to belong to the same genus as *Palmella cruenta*, as first indicated by Brown, and confirmed by Sir W. Hooker. Greville's figures of the Scotch plant closely resemble this; but the continental plants described by Shuttleworth and others would seem congeneric with *Protococcus*, *Chlamidococcus*, and *Chlamidomonas*, since they produce active zoospores, the forms which Shuttleworth described as distinct Infusoria, as species of *Astasia*. Nearly connected with this continental snow-plant, if not identical, is the *Protococcus pluvialis*, described so elaborately by Cohn, which moreover appears to be synonymous with the *Discerea purpurea* of Morren.

The following is a description of the red snow, brought home by Capt. Parry, from our own observation. It may be noticed as remarkable that, after being kept so many years in a moist state in a stoppered bottle, the structure appears almost unchanged, the only difference being the assumption of a green colour on the surface of the masses when exposed to light. Frond an indefinite gelatinous mass densely filled with spherical cells, about 1-200″ in diameter (Pl. 7. fig. 3 *d*); cells with a distinct membrane, their contents consisting of numerous tolerably equal granules, red or green (see above). Between the large cells lie patches of minute red granules (as in *Palmella cruenta*, Pl. 7. fig. 3 *a*, *b*), apparently discharged from the large cells. Bauer and Greville both describe this as the mode of propagation of the plant; but it is probable that the cells also increase by division when actively vegetating.

Bibl. Brown, *Appendix to Ross's 1st Voyage*, 1819; DeCandolle, *Bibl. univ. Genève*, 1824; Hooker, *Append. to Parry's Second Voyage*; Greville, *Crypt. Fl.* pl. 231; Shuttleworth, *Bibl. univ. Genève*, 1840; Morren, *Mém. Acad. Bruxelles*, xiv. 1841; Flotow, *Nova Acta*, xx. 11; Cohn, *Nova Acta*, xxii. 605.

RENULINA, Blake.—Minute subglobular, hollow, calcareous bodies, 1-200″ in diameter, often silicified, entering largely into the composition of the Coralline Oolite; regarded as probably organic by Sorby, and referred to the Foraminifera by Blake. (Sorby, *Qu. Geol. Jn.* vii. 1851, 1; Blake, *Jn. Mic. Soc.* 1876, 262.)

RENULI'TES, Lam. (*Renulina*, Blainville).—A broad, reniform modification of *Vertebralina*, one of the Porcellaneous Foraminifera.

Bibl. Carpenter, *Introd. For.* 74.

RE'OPHAX, Montfort.—A simple, uniserial subspecies of *Lituola*, straight or curved, chambers often angular or rugged in outline. Abundant in many seas. (Parker and Jones, *Ann. N. H.* 3. vi. 346; Brady, *Qu. Mic. Jn.* n. s. xix. 51.)

REPTOMONAS, Kt.—A genus of Rhizo-Flagellate Infusoria. Creeping; flagellum

single, pseudopodia arising from the postero-ventral surface. *R. caudata*; in hay-infusions, and decaying grass; length 1-1000″. (Kent, *Inf.* 223.)

RESERVOIRS FOR SECRETIONS IN PLANTS. See SECRETING ORGANS of Plants.

RETE MUCOSUM. See SKIN.

RETEPʹORA, Lamk.—A genus of Infundibulate Cheilostomatous Polyzoa, family Escharidæ.

Char. Zoary leafy, reticular, fragile; cells on one surface only, short, and not prominent. Two British species:

R. reticulata. Wavy and convolute, upper side warty and very porous.

R. Beaniana. Umbilicate, funnel-shaped, wavy; interspaces unarmed.

BIBL. Johnston, *Br. Zooph.* 353; Gosse, *Mar. Zool.* 18; Hincks, *Polyzoa*, 388.

RETICULAʹRIA, Bull.—A genus of Myxomycetes (Gasteromycetous Fungi) characterized by the indeterminate, thin simple peridium, bursting irregularly, with the branched, shrubby, reticulated capillitium adherent to it. Several species are British; they are rather large plants, growing over recently felled timber or on hollow trees, rails, &c., with great rapidity.

BIBL. Berk. *Br. Fl.* ii. pt. 2. 308; Fries, *Sum. Veg.* 449; *Syst. Mycol.* iii. 83.

RETICULAʹRIA, Carpenter.—Rhizopoda with long slender pseudopodia, which meet and reticulate: as in *Lieberkuehnia*, and other FORAMINIFERA.

BIBL. Carpenter, *Introd. For.* 28; *Microscope*, 476.

RETINA. See EYE.

RHABDAMʹMINA, Sars.—A relatively large Arenaceous Foraminifer, usually triradiate, but sometimes with four or even five hollow rays or tubes, and sometimes consisting of only the central chamber elongated on two sides, forming one tube swollen in the middle. *R. abyssorum*, Sars, Atlantic and Pacific; *R. linearis*, Brady, West Indies and South Atlantic, at great depths. (Carpenter, *Soirée, Mic. Soc.* 1870, 5; Brady, *Jn. Mic. Sc.* n. s. xix. 37.)

RHABDITIS, Duj. See ANGUILLULA.

RHABDOGOʹNIUM, Reuss.—A three- or four-angled Orthocerine Foraminifer.

BIBL. Reuss, *Sitz. Ak. Wien*, xliv. 367.

RHABDOLIʹTHES, Schmidt.—Minute, subcylindrical, calcareous bodies, about 1-3000″ length, usually consisting of a rod and a terminal circlet of smaller rods (1-25000″), simple or confluent. Abundant with coccoliths in the mud of the Adriatic; and fossil with the same in the chalk of Manitoba and Nebraska. Found also in the ocean-ooze by W. Thomson, and referred by him to small floating spherules (possibly vegetables) formed by their attached bases, and termed by him *Rhabdospheres*. (Schmidt, *Sitz. Ak. Wien*, lxii. 669, and *Ann. N. H.* 4. x. 369; Dawson, *Canad. Nat.* vii. 256; W. Thomson, *The Attlantic*, i. 221.)

RHABDONEʹMA, Kütz.—A genus of Diatomaceæ.

Char. Frustules tabular, depressed, compound, fixed by a stalk arising from one of the angles, with interrupted vittæ (front view), vittæ capitate; valves transversely striate, striæ extending into the front view, and forming numerous longitudinal series.

Marine; upon Algæ. Striæ visible under ordinary illumination; the dark lines or vittæ correspond to more or less complete internal septa; frustules connected with each other by gelatinous cushions (isthmi).

Conjugation and the formation of sporangia have been observed.

R. arcuatum (*Striatella arcuat.*, Ralfs) (Pl. 17. fig. 18). Vittæ in two marginal rows, isthmi convex. Length 1-300″.

R. minutum (*Tessella catena*, Ralfs). Vittæ in two marginal rows; transverse striæ faint. Length 1-1200 to 1-960″.

R. adriaticum. Vittæ forming four rows (interrupted in the middle, and again between the middle and the margin on each side); transverse striæ distinct; isthmi concave. Length 1-480 to 1-170″.

BIBL. Kützing, *Bacill.* 126, and *Sp. Alg.* 115; Ralfs, *Ann. N. H.* xi. 455, and xii. 104; Smith, *Diat.* ii. 32; West, *Micr. Jn.* 1858, 186; Arnott, *Micr. Jn.* 1858, 91; Rabenht. *Alg.* i. 305.

RHABDOPLEUʹRA, Allman.—A genus of Polyzoa according to Allman, and of Hydroida according to Sars. Zoary tubular, creeping or incrusting, septate, annulate, bodies with an oral disk. It connects the two classes, and presents many features of great interest. Allman considers that its polypary resembles that of the Graptolites. Two species, on shells from deep water.

BIBL. Allman, *Qu. M. Jn.* 1874; Sars, *Qu. M. Jn.* 1874, 23; Lankester, *Qu. Mic. Jn.* 1874, 77; Hincks, *Polyz.* 577.

RHABDOSTYʹLA, Kt.—A genus of Peritrichous Infusoria. Solitary, like *Vorticella*, but with a rigid, short pedicle. Seven species; salt or fresh water. (Kent, *Inf.* 664.)

RHAGADOSTOMA, Körb.—A genus of Micro-lichens parasitic on the thallus of *Solorina crocea*. Spores 2–4, in lanceolate fugacious thecæ, large, simple, becoming 2-locular, colourless. (Lindsay, *Qu. Mic. Jn.* 1869, 344.)

RHAPHIDOGLŒ'A, Kütz.—A genus of Diatomaceæ.

Char. Frustules navicular, arranged in radiating crowded rows in a globose gelatinous mass. Marine.

R. micans (Pl. 19. fig. 11). Rows of frustules irregular, obsolete; valves linear-lanceolate, subulate, somewhat acute. Length 1-140″.

Three other species.

Bibl. Kützing, *Bacill.* 10; id. *Sp. Alg.* 97.

RAPHIDOMONAS, Stein.—A genus of Flagellate Infusoria. Free, green, flagellum single; mouth anterior, with a defined pharynx; an anterior row of trichocysts. *R. semen* = *Monas s.*, Ehrb.; length 1-500″; marsh-water, among decaying *Sphagnum*. (Kent, *Inf.* 391.)

RHAPHONE'IS, Ehr.—A genus of Diatomaceæ.

Char. Frustules single, quadrangular, navicular; valves without a median aperture (nodule?); median sutural line longitudinal. Marine. = *Doryphora* without a stalk.

Eleven species.

Bibl. Ehrenberg, *Ber. Berl. Akad.* 1844, 74; Kützing, *Sp. Alg.* 49.

RHINOPS, Hudson.—A genus of Rotatoria.

Bibl. Hudson, *Ann. Nat. Hist.* January 1869.

RHINOTRICHUM, Corda.—A genus of Mucedines (Hyphomycetous Fungi), characterized by more or less clavate threads studded with spicules, to which the spores are attached. Several species occur in this country. A very beautiful rose-coloured species has lately been gathered in rabbits' dung.

Nematozonum, Desm., differs in bearing necklaces of spores.

Bibl. Berk. *Outl.* 348; Cooke, *Handb.* 590.

RHIPIDODEN'DRON, Stein.—A genus of Flagellate Infusoria. Bodies ovate, contained in elongated parallel, granular tubes, forming a branched zoary. Two species; freshwater. (Kent, *Inf.* 285.)

RHIPIDOPH'ORA, Kütz.—A genus of Diatomaceæ.

Char. Those of *Licmophora*, except that the frustules are each furnished with a distinct stipes; but as this is not always the case, the character is of little or no value. Marine.

Three British species (Smith); twelve others (Kützing).

R. paradoxa (Pl. 17. fig. 19). Stipes filiform, dichotomous; frustules in front view broadly wedge-shaped, somewhat acute at the base. Length of frustules 1-540 to 4-480″.

RHIZAMMINA, Brady.—A thread-like Foraminifer, or chitino-arenaceous branching tube (1-50″ diam.), forming a tangled weed-like tuft. *R. algæformis*, from 2160 fathoms near Juan Fernandez. (Brady, *Jn. M. Soc.* n. s. xix. 39.)

RHIZIDIUM, Braun.—A genus of Unicellular Algæ, allied to *Chytridium*. At first unicellular, then bicellular, and with delicate multipartite rootlets; cells oblong; fructiferous cells beneath the apex; zoospores with a cilium. Parasitic in *Euglenæ* and *Nitellæ*.

Bibl. Braun, *Monatsb.* 1856, 591; Rabenht. *Alg.* iii. 284.

RHIZINA, Fr.—A genus of Helvelloidei (Ascomycetous Fungi), distinguished from *Peziza* by the bullate hymenium, concave beneath, and furnished with rooting fibrils.

Two species have been found in this country, on sandy banks where the heath has been burnt.

Bibl. Fr. *Syst. Myc.* ii. 33; Currey, *Linn. Tr.* xxiv. 493; Cooke, *Handb.* 664.

RHIZOCLONIUM, Kütz.—A genus of Confervaceæ (Confervoid Algæ), distinguished by the decumbent habit and the short, root-like appendages to the branches.

Kützing includes here many of our British Confervæ:

R. rivulare, C. Filaments simple, diam. 1-900″, fine bright-green bundles 2 to 3 feet long; in streams and rivers; common (Dillwyn, pl. 39).

R. tortuosum, Dillw. Filaments simple, diam. 1-800″, rigid, curled and twisted, forming large strata; in salt-water pools; abundant (Dillwyn, pl. 46).

R. arenosum, Carm. Filaments simple. diam. 1-1000 to 1-1800″; in dirty-green strata; sandy sea-shores.

R. obtusangulum, Lyngb. (Pl. 9. fig. 12). Filaments branched, diam. 1-1400″; pale-green, stratified; sandy sea-shores.

R. riparium (*Jergensii*, Kütz.). Filaments branched, diam. 1-1400 to 1-1800″. Apparently not distinct from the preceding.

On sandy sea-shores; not uncommon (*Engl. Botany*, pl. 2100).

R. implexum, Dillw. Filaments simple, diam. 1-2000″; bright green; forming large strata, on mountain-rocks (Dill. *C. implexa*, tab. B).

R. arenicolum, Berk. (*Kochianum*, Kz.). Filament 1-2000 to 1-2400″; mountain-rocks (Berkeley, *Gleanings*, pl. 13. fig. 3).

Bibl. Harvey, *Mar. Alg.* 206, pl. 24 F; Kütz. *Sp. Alg.* 385; *Tab. Phyc.*; *Br. Fl.* ii. pt. 1. 354; Dillwyn, *Br. Conferv*æ; Rabenht. *Alg.* iii. 329.

RHIZOG'LYPHUS. See Acarus, p. 5.

RHIZOMOR'PHA.—The name given by authors to certain mycelioid expansions with a dark bark, which have been traced to *Polypori* and *Sphæriacei*. Many of the forms which occur in mines are remarkable for their luminosity.

Bibl. Berk. *Int. Crypt. Bot.* p. 266.

RHIZONE'MA, Thw.—A genus of Oscillatoriaceæ (Confervoid Algæ) = *Dictyonema*, Kütz. This curious plant (*R. interruptum*) differs from its allies by the gelatinous sheath being composed of distinct cells and furnished with branched root-like processes, which anastomose freely. The cell-contents are deep blue-green, with occasional yellowish interstitial cells.

Bibl. Thwaites, *Eng. Bot. Supp.* pl. 2954; Kütz. *Sp. Alg.* 321; *Tab. Phyc.* ii. pl. 40. f. 5.

RHIZOPHORA'CEÆ.—A family of Dicotyledonous plants, to which belong the celebrated Mangrove-trees of the tropics. They are remarkable for the general occurrence of a ramified form of *liber-cell* (Pl. 48. fig. 31). The long woody radicles pushed out by the fruits, while still attached to the parent tree, contain a vast number of these ramified cells with very thick walls.

RHIZOPHYD'IUM, Schenk, = *Chytridium*, sp.

RHIZOP'ODA, Duj., or better, *Pseudopoda*, Ehr.—A Class of the animal subkingdom Protozoa.

Char. Gelatinous, structureless aquatic animals, mostly minute, locomotive organs consisting of variable retractile root-like processes—pseudopodia or false legs; no mouth.

The food-particles are drawn into the body by the pseudopodia, as described under *Actinophrys*. The body is sometimes naked, at others enclosed in a carapace or external skeleton, which is either chitinous, calcareous, or siliceous. A nucleus and a contractile vesicle are sometimes present, sometimes absent. In some, the protoplasm contains granules and yellow cells; these have been supposed to be parasitic organisms, a rudimentary form of liver, or reproductive organs. The presence of the contractile vesicle in some Rhizopoda, and its absence in others, is entirely opposed to the view of Stein and Kent, that the presence of a contractile vesicle is a character of animality; unless many of the Rhizopoda be referred to the Vegetable Kingdom. The Class is divided into four Orders, thus:—

Reticularia. Pseudopodia slender, anastomosing to form meshes.—Foraminifera, *Lieberkühnia*, *Labyrinthula*, &c.

Radiolabia. Pseudopodia radiating.—Actinophryina, *Acanthometra*, Polycystina, *Thalassicolla*.

Lobosa. Pseudopodia short, variable, not anastomosing.—Amœbæa, Arcellina.

Gregarinida. Pseudopodia absent; these are often considered a distinct Class of Protozoa.

Bibl. Dujardin, *Ann. Sc. Nat.* i., iii., iv.; Schultze, *Polythal.*, 1834; Carpenter, *Phil. Tr.* 1856, 1859, 1862; Huxley, *Invertebrata*; Williamson, *Tr. Mic. Soc.* 1852, 169, and ii. 159; Reichert, *Ann. N. H.* x. 1862, 401; Kölliker, *Zeitschr. wiss. Zool.* 1849; Lieberkühn, *ibid.* 1856, 308; Carter, *Rhizopoda of Eng. & India*, *Ann. N. H.* 1865; *Tr. Mic. Soc.* 1849, 174; Müller, *Müll. Archiv*, 1858; Focke, *Physiol. Stud.* 1854; Fresenius, *Beitr. z. mikr. Organ.* 224; Müller, *Monatsb. Akad. Berlin*, 1856; Bailey, *Americ. Journ. Sci.* xv.; Claparède & Lachmann, *Infus.*; Haeckel, *Radiolarien*, 1862; *Gener. Morphol.*; Archer, *Qu. M. Jn.* 1870-78; Hertwig & Lesser, *Arch. mik. An.* 1874, x. *Suppl.*; Schultze, *ibid.* x., xi., xiii.; Hertwig, *Radiol.* (*Histol.*) 1876; Wallich, *M. M. Jn.* xiii. 210; *Ann. N. H.* 1877, xix. 158; Claus, *Zoologie*; Leidy, *Freshw. Rhiz. N. Amer.* 1879; *Jn. Mic. Soc.* 1880, 288; Butschli, *Bronn's Klass. &c.* 1880 (*& the Bibl. therein*); Cienkowski, *Schultze's Archiv*, 1876, xii. (*new genera*); Pascoe, *Zool.* 1880, 6.

RHIZOPO'GON, Fries.—A genus of Hypogæi (Gasteromycetous Fungi). *R. rubescens* is found in sandy ground. (Pl. 27. fig. 8, sporophores).

RHIZOSELE'NIA, Ehr.—A doubtful genus of Diatomaceæ.

Char. Frustules elongate, subcylindrical, marked with transverse or spiral lines, ends oblique or conical, and with one or more long terminal bristles; marine and fossil.

Four British species: *R. styliformis*, *R. imbricata*, *R. setigera*, and *R. alata*.

R. alata (Pl. 51. fig. 25). *R. americana* (Pl. 50. fig. 46).

The British species were obtained from *Salpa*, *Ascidia*, and *Noctiluca*.

Bibl. Ehr. *Abh. Berl. Ak.* 1841, 291; Kütz. *Sp. Alg.* 24; Brightwell, *Micr. Jn.* 1858, 94.

RHODOM'ELA, Ag.—A genus of Rhodomelaceæ (Florideous Algæ), containing two tolerably common British species, with feathery, inarticulate, branched fronds, the branches composed of concentric layers of oblong, colourless cells, with a cortical layer of minute coloured cells. Colour of *R. lycopodioides* purplish brown, becoming black; height 4 to 18″. Colour of *R. subfusca* brownish or reddish; height 4 to 10″. The *ceramidia* are stalked on the ramuli, occurring in summer; the *stichidia*, with tetrahedral tetraspores, occur in a similar situation in winter; the *antheridia* (observed in *R. subfusca*) also occur in tufts in the same position.

Bibl. Harvey, *Mar. Alg.* 78; Tulasne, *Ann. Sc. Nat.* 4. iii. 20.

RHODOMELA'CEÆ.—A family of Florideous Algæ. Red or brown sea-weeds, with a leafy or filiform, areolated or articulated frond, composed of polygonal cells. *Fructification*: 1. *Conceptacles* (*ceramidia*) external, ovate or urn-shaped, furnished with a terminal pore, and containing a tuft of pear-shaped spores; 2. *antheridia*, borne in tufts in similar situations; 3. *tetraspores* immersed in distorted ramuli or in lanceolate receptacles (*stichidia*), usually in rows.

Synopsis of the British Genera.

Odonthalia. *Frond* flattened, linear, with an obsolete midrib, pinnatifid, alternately inciso-dentate.

Rhodomela. *Frond* cylindrical, inarticulate, opaque. *Tetraspores* contained in pod-like receptacles (*stichidia*).

Bostrychia. *Frond* cylindrical, inarticulate, dotted; the surface-cells quadrate. *Tetraspores* in terminal pods.

Rhytiphlœa. *Frond* cylindrical, inarticulate, transversely striate. *Tetraspores* in pod-like receptacles.

Polysiphonia. *Frond* cylindrical, articulated wholly or in part; the branches longitudinally streaked. *Tetraspores* in distorted ramuli.

Dasya. *Frond* cylindrical, the stem inarticulate; the ramuli articulated, composed of a single string of cells. *Tetraspores* in pod-like receptacles (*stichidia*), borne by the ramuli.

RHODOSPOR'EÆ. See Algæ.

RHODYME'NIA, Grev.—A genus of Rhodymeniaceæ (Florideous Algæ), containing seven British species, beautiful, brightly-coloured sea-weeds, growing on rocks or larger Algæ, having a flat membranous or somewhat leathery frond, ribless and veinless, of parenchymatous texture. (*R. Palmetta*, Pl. 4. fig. 8.) Most are not more than 2″ high, but *R. laciniata* and *palmata* grow to 10″ and 18″. The colour is mostly rose- or blood-red. The *coccidia* are formed on the lacerated margins or the tips of lobes of the frond. The *tetraspores* form cloudy spots along the margin, or are scattered, tetrahedrally divided. The *antheridia* likewise form patches on the surface of the frond, in *R. Palmetta* and *palmata*.

Bibl. Harvey, *Mar. Alg.* 124, pl. 16 A; Thuret, *Ann. Sc. Nat.* 4. iii. p. 19, pl. 3.

RHODYMENIA'CEÆ.—A family of Florideous Algæ. Purplish or blood-red sea-weeds, with an expanded or filiform inarticulate frond, composed of polygonal cells; occasionally traversed by a fibrous axis. Superficial cells minute, irregularly packed, or *rarely* arranged in filamentous series. *Fructification*: 1. *Conceptacles* (*coccidia*), external or half-immersed, globose or hemispherical, imperforate, containing beneath a thick envelope a mass of spores affixed to a central column; 2. *antheridia*, collected in flat patches or sori; 3. *tetraspores*, either dispersed through the whole frond, or collected in indefinite cloudy patches. British Genera:

* Frond flat, expanded, leaf-like, dichotomous or palmate.

Stenogramme. *Conceptacles* linear, ribless.

Rhodymenia. *Conceptacles* hemispherical, scattered.

** Frond compressed or terete, linear or filiform, much branched.

Sphærococcus. *Frond* linear, compressed, two-edged, distichously branched, with an obscure midrib.

Gracilaria. *Frond* filiform, compressed, or flat, irregularly branched; the central cells very large.

Hypnea. *Frond* filiform, irregularly branched, traversed by a fibro-cellular axis.

RHOICOSPHE'NIA, Grunow.—A genus of Diatomaceæ, = arcuate *Gomphonema* with

a central nodule in the curved side. *R. curvata* (Pl. 52. fig. 19).

BIBL. Rabenht. *Alg.* i. 112.

RHOIKONE'IS, Grun.—A subgenus of *Achnanthidium*, comprising two species, found in the North Pacific.

BIBL. Rabenht. *Alg.* i. 109.

RHOPALOMY'CES, Corda.—A genus of Mucedines (Hyphomycetous Fungi), nearly allied to ASPERGILLUS, but having the

Fig. 618. Fig. 619.

Rhopalomyces nigra.

Fig. 618. Tufts on wood. Nat. size.

Fig. 619. Fertile filaments. Magnified 200 diameters.

spores single (fig. 619), and not in moniliform series. The single spores are borne on minute spines (fig. 619, left-hand head). They are mildews growing over decayed wood, matting, dung, &c. Two new British species are described by Berkeley and Broome, found growing together.

BIBL. Berk. and Broome, *Ann. N. H.* 2. vii. 96, pl. 5.

RHOPALOSI'PHUM, Koch.—A genus of Aphidæ. Six species, on the currant and gooseberry, *Sonchus*, *Alisma*, *Ligustrum*, and *Berberis*. (Buckton, *Aphidæ*, *Ray Soc.* ii. 9.)

RHUBARB.—Garden rhubarb (*Rheum undulatum*, and other species) affords, in the large edible petioles, excellent specimens of SPIRAL-fibrous STRUCTURES, spiral, annular, and reticulate vessels and ducts: these are readily isolated by the help of a needle from a fragment of cooked rhubarb placed in water on a slide, and are well seen by polarized light. The petioles and leaves likewise contain bundles of acicular RAPHIDES. The roots also contain special receptacles for a characteristic secretion.

RHYNCHÆTA, Zenker.—A genus of Acinetina. Body ovate, free or attached, with a long anterior suctorial tentacle. *R. cyclopum*, freshwater, on *Cyclops*. (Kent, *Inf.* 806,)

RHYNCHOL'OPHUS, Dugès, = *Erythræus*, Latreille (not Dugès). A genus of Arachnida, of the order Acarina, and family Trombidina.

Char. Palpi large, free; labium penicillate; mandibles ensiform, very long; body entire; coxæ very remote, legs palp-like, *i. e.* dilated at the end, posterior very long.

Species numerous; found in woods, under leaves, and in mosses.

R. cinereus (Pl. 6. fig. 40: *a*, labium with palp; *b*, tarsus; *c*, plume of labium more magnified; *d*, mandible).

BIBL. Dugès, *Ann. Sc. Nat.* 2. i. 30; Gervais, *Walckenaer's Arachnid.* iii. 175; Koch, *Deutschl. Crust.*; Murray, *Econ. Ent.* 124.

RHYNCHONE'MA, Ktz.—A genus of ZYGNEMACEÆ (which see).

BIBL; Rabenht. *Alg.* iii. 229.

RHYNCHOP'AGON, Werneck (Rotatoria) = *Diglena* with a bilobed rostrum! Two species. (Werneck, *Ber. Berl. Ak.* 1841, 377.)

RHYNCHOP'ORA, = *Lepralia* pt. *R. bispinosa* = *L. bisp.*

RHYNCHO'PRION. See PULEX.

RHYTISMA, Fries.—A genus of Phacidiacei (Ascomycetous Fungi), growing upon the leaves of trees and shrubs, forming dark patches or spots on the surface, breaking through the epidermis with little scales or irregular fissures. *R. acerinum* is exceedingly common, forming large black spots on the leaves of the sycamore and maple; the thecasporous fruit is perfected (on the dead fallen leaves) in spring; MELASMIA *acerina*, which occurs in autumn, appears to be a preparatory form of this plant. *R. salicinum* is common on willow-leaves.

BIBL. Berk. *Br. Fl.* ii. pt. 2. 290; Grev. *Crypt. Fl.* pl. 118; Fries, *Sum. Veg.* 370; Tulasne, *Compt. Rendus*, 1852 (*Ann. N. H.* 2. viii. 118); Cornu, *Compt. Rend.* 1878, *Grevillea*, vii. 100.

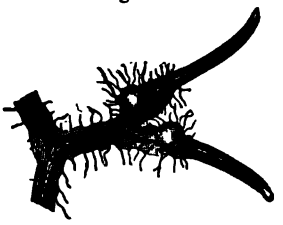
RICASO'LIA.—A genus of Phyllodei (Lichenaceous Lichens).

Char. Thallus lobate or laciniate, affixed by fasciculate rhizinæ; gonidia small, yellow-green; spores 1–3-septate. (Leighton, *Brit. Lich. Flora*, 112.)

RICCIA, L.—A genus of Ricciæ (Hepaticæ), consisting of minute green thalloid productions growing upon damp ground or floating on water, distinguished from the allied forms by the capsules being immersed in the substance of the frond, destitute of perichæte and perigone, while the archegone

permanently encloses the sporange as an adherent epigone, bearing a persistent style-like neck (figs. 621, 622). The antheridia

Fig. 620.



Riccia fluitans.

Lower surface of a fragment of the frond, with three imbedded sporanges projecting, their orifices being on the upper surface.

Magnified 5 diameters.

are globose sacs contained in special cavities, the orifices of which, narrowed into a neck, project as short processes from the surface (cuspides). The epigone being adherent to the sporange, the spores appear to lie immediately in the cavity of the former when

Fig. 621. Fig. 622.

Riccia fluitans.

Fig. 621. Vertical section through the frond and sporange contained in its substance.

Fig. 622. Sporange, with persistent epigone, extracted from the frond.

Magnified 25 diameters.

ripe; they are unaccompanied by elaters, and escape by irregular rupture of the epigone. Several species occur in Britain.

* *Terrestrial.*

R. glauca, L. Frond without membranous scales below, fleshy, ovate-oblong, two- to three-lobed, 1-2 to 1″ in diameter, the divisions dichotomous, growing in orbicular tufts, surface smoothish, punctate, glaucous green. On banks.

R. crystallina, L. Differing from the last chiefly in larger size and lighter colour, and having large cavernous air-cells opening widely on the upper surface. Damp mould.

** *Aquatic.*

R. fluitans, L. (fig. 620). Fronds without scales below, 1-2 to 2″ long, repeatedly forked, segments linear, notched at the ends; when placed on damp earth it produces radical hairs, (fig. 621-2). Stagnant water.

R. natans, L. Fronds with long reticulated scales below, obcordate, 1-2″ long, or with the two lobes again divided; scales of the lower surface purple. On stagnant pools.

Bibl. Hook. *Br. Fl.* ii. pt. 1. 102; Bischoff, *Nova Acta*, xvii. 909; Lindenberg, *ibid.* xviii. 361; Hofmeister, *Vergl. Unters.* 43; Kny, *Jahrb. wiss. Bot.* v.; *Tr. Mic. Soc.* 1880, iii. 125.

RICCIE'Æ.—A tribe of Liverworts or Hepaticæ, consisting of delicate, green, membranous fronds, spreading on the ground or floating on water. The fruits are always sessile on the frond, more or less imbedded in its substance according to the thickness; the spores are unaccompanied by elaters.

Synopsis of British Genera.

Sphærocarpus. Archegones dorsal, on a lobed membranous frond, sparingly aggregated. Perichæte obtusely conical or pear-shaped; perforated at the summit, continuous with the frond. Perigone wanting. Epigone crowned by the deciduous style. Sporange at length free, indehiscent.

Riccia. Archegones immersed in the frond, scattered, neither emergent nor exposed on the surface until burst. Perichæte and perigone undistinguishable. Epigone crowned by the enlarged, long, persistent style, adherent to the sporange. Sporange bursting irregularly.

RICE.—This grain is produced by the grass called *Oryza sativa*. The seed is remarkable for the hard character of the albumen, which is explained at once when we examine a section under the microscope (Pl. 46. figs. 12 & 13). The cells are filled with very small starch-grains, which are packed so closely that they assume a parenchymatous form and present the appearance of a continuous tissue (as in maize). The cohesion of the starch-granules is the cause of the peculiar grittiness of rice-flour. See Starch.

RIMULA'RIA, Nyl.—A genus of Lecideinei (Lichenaceous Lichens).

Char. Apothecia black, rounded, depressed in the centre, dehiscing by a subradiate fissure; spores simple. (Leighton, *Lich. Flora*, 438.)

RIMULI'NA, D'Orb.—A Nodosarine

Foraminifer, with oblique chambers, and a long slit-like orifice on the edge of the last chamber. Adriatic. (Parker, J. & B., *Ann. N. H.* 3. xvi. 15.)

RIND.—This word is used to denote a structure intermediate between epidermis and bark,—a compound structure consisting of several, or many layers of cells and even of distinct forms of tissue, but not presenting the characteristic kinds and arrangement which occur in true BARK.

RIVULA'RIA, Roth.—A genus of Oscillatoriaceæ (Confervoid Algæ), subdivided by Kützing, and restricted to the forms in which there is a distinct *manubrium* or elongated cell next to the globular basal cell. As thus defined, it contains only a few aquatic species, the rest being transferred to PHYSACTIS, EUACTIS and allied genera.

R. angulosa, Roth. Frond floating, globose, dirty-green; manubria oblong and curved, or oblong-ovate and abbreviated; filaments torulose at the base, interruptedly articulated at the apex. *Eng. Bot.* 968.

R. Boryana, Kg. (Pl. 6. fig. 18). Frond globose, greenish brown; the size of a cherry; manubria large; sheaths ventricose, colourless, with plaited constrictions; filaments moniliform or interruptedly articulate, flagelliform. *β. flaccida*, smaller, filaments flaccid, not interrupted. Doubtful species: *R. botryoides*, and *R. plana*.

R. plicata, Harv. Frond densely gregarious, compresso-plicate, often hollow and ruptured, dark green; filaments spuriously dichotomous, attenuated.

BIBL. Kützing, *Sp. Alg.* 336; *Tab. Phyc.* ii. pls. 67, 68; Harvey, *Br. Alg.* 1 ed. 150; Hassall, *Alg.* 262, pl. 64; *Eng. Bot. Supp.* pl. 2911.

ROBERTI'NA, D'Orb.—A modification of the Bulimine form of Foraminifera with long oblique chambers, 7–10 in the last whorl, and interdigitating; orifice comma-shaped. Recent and fossil.

BIBL. Carpenter, *For.* 196; Parker and Jones, *Phil. Tr.* clv. 375.

ROBERTSO'NIA, Br. — A genus of Copepodous Entomostraca. *R. tenuis*, in dredgings. (Brady, *Copepod., Ray Soc.* ii. 25.)

ROBULI'NA, D'Orb.—A common form of *Cristellaria*, in which the orifice is triangular.

BIBL. Williamson, *Rec. For.* 24 (*Cristellaria*); Parker and Jones, *Ann. N. H.* 2. xix. 289.

ROCCEL'LA, Ach.—A genus of Ramalodei (Lichenaceous Lichens)), growing on marine rocks, remarkable as furnishing the dye called orchil or archil. *R. tinctoria*, *phycopsis*, and *fusiformis*, the British species, grow only in the extreme south of England.

BIBL. Hook. *Br. Fl.* ii. pt. 1. 225; *Engl. Bot.* pls. 211, 728; Leighton, *Lich. Fl.* 73.

ROCKS.—Rocks are roughly divided, according to their origin, into an *eruptive* and a *sedimentary* series. Again, the eruptive rocks may be classed in two great groups, the *vitreous* and the *crystalline*; the former being in great part structureless, while the latter consist essentially of crystals. A microscopic examination of the vitreous rocks, such as Obsidian, pitchstone, pearlite &c., shows, however, that rocks of this class are not wholly devoid of structure, since they almost invariably contain large numbers of minute crystals (*microliths*) too small to be referred with certainty to any known mineral species, together with more or less sparsely disseminated crystals of larger size. The microliths, moreover, are frequently disposed in approximately parallel and often tortuous bands; while sometimes, bands of structureless matter, glass of a slightly different colour and density, are seen to traverse the rock. These bands, as shown in Pl. 42. fig. 8, whether consisting only of glass, or whether represented by lines of microliths, are very characteristic of lava-streams, and are indicative of their fusion and flow. Such structures are not always apparent to the naked eye; and in these cases the microscope often serves to demonstrate the conditions under which certain rocks have been formed.

In the examination of the crystalline rocks, which are essentially built up of crystals, frequently of different minerals, and pertaining to various crystallographic systems, it becomes necessary to determine their optical characters; and for this purpose the employment of polarized light affords the best means of discriminating between them; since, in thin sections of fine-grained rocks, the application of reagents to any particular crystal or grain is a matter of some difficulty. Before entering, however, upon the subject of the crystalline rocks, it may be well to take a glance at a few of the most characteristic features presented by the vitreous series.

In the Obsidians, pitchstones, pearlites

and tachylytes, microliths and other minute structures are almost always present. Some of these are mere opaque hairs or threads, called *trichites*, strangely bent and twisted (Pl. 42. fig. 3), and concerning whose mineralogical character nothing definite is known. Others are fine needles, sometimes with lateral growths, which, as in the pitchstone of Corriegills in Arran (Pl. 42. fig. 5), resemble, when highly magnified, the fronds of ferns. These spicular bodies or *belonites* have been referred to augite. In many of the obsidians and pearlites, the microliths are minute elongated prisms or cylinders, and their ends often appear to be rounded. They commonly form dense streams, their longest axes lying in approximately uniform directions, except where larger crystals occur; and at these points the streams are deflected and appear to sweep round the obstacles. In some of the obsidians and vitreous basalt-lavas, the crystallites exhibit a more or less complex structure, as in Pl. 42. fig. 4, the relation of which can occasionally be traced to perfectly developed crystals. In the pearlites and in some other glassy rocks, curious little cracks occur, which separate the rock into minute spheroids (Pl. 42. fig. 7). The cracks are seldom continuous all round the form, but thin away in a very characteristic manner. There is no nucleus, and the phenomenon appears to be solely due to shrinkage upon cooling. The streams of microliths which often traverse these rocks, pass without interruption through this pearlitic structure.

Spherules are sometimes plentifully developed in vitreous rocks, and result in many cases from crystallization around a point or along a line (*axiolites*) of limited extent. Pl. 42. fig. 6 shows parts of two spherules, in an obsidian from the Lipari Isles, which have partially coalesced; and in some specimens they may be found united in continuous strings.

In the felspars and other minerals occurring in certain lavas, enclosures of vitreous matter are sometimes visible. These are small portions of the glassy magma which have been entrapped by the crystals during their formation. Pl. 42. fig. 2 shows glass lacunæ of this kind enclosed within a felspar crystal in one of the lavas of Etna.

The crystalline eruptive rocks consist, as already stated, of crystals or crystalline grains of various minerals, and it is necessary to study their optical characters in order to determine them with any precision. Before entering, however, upon this method of investigation the student should become familiar with ordinary hand specimens of the chief rock-forming minerals, and should acquire some knowledge of the simple tests, both physical and chemical, which distinguish the different species. In the absence of such elementary knowledge, deductions based solely upon microscopic observations are sure to be untrustworthy, if not worthless. The text-books from which this rudimentary instruction may be derived are too numerous to need mention. For the study of the optical properties of minerals the student may advantageously consult the works of Dana, Zirkel, Rosenbusch, von Lasaulx, Fouqué, Lévy, and other recent contributors to microscopic petrography.

In a mere sketch of the subject, such as this must necessarily be, it is impossible to do more than allude to the microscopic characters of a few of the most typical rocks; and in doing so, we may begin with a thin slice of granite (Pl. 42. fig. 9). The student doubtless knows beforehand that he is dealing with a rock composed essentially, of felspar, mica, and quartz. But there may be more than one species of felspar present, and the mica may also be of various kinds. To determine the character of the felspars, he must study their angles of extinction between accurately crossed Nicol's prisms; and to do this, it is necessary to employ a microscope with a properly divided, rotating stage, which can be centred correctly for any object-glass which may be used, so that a minute speck in the preparation can be made to revolve immediately beneath the point of intersection of two crossed spider-lines set within the eyepiece. He can, in most cases, ascertain whether the felspars crystallize in the monoclinic or in the triclinic system by observing the character of the twinning in polarized light. The monoclinic felspars are usually twinned on what is known as the Carlsbad type, and show only two differently coloured halves or lamellæ; while the triclinic felspars are striated by numerous twin-lamellæ, which polarize in different alternating colours; unless, of course, in either case, the plane of section coincides with the plane of composition of the twin-lamellæ, *i. e.* the direction in which the plates appear to be stuck together. In the monoclinic felspars, the maximum extinc-

tion between crossed Nicols either coincides with the edge formed by the union of the basal plane and the clinopinakoid, or else lies at right angles to this edge; while in the trichnic system the maximum extinction does not coincide with, or stand at right angles to the homologous edge formed by the basal plane and the brachypinakoid, but occurs in some azimuth on one or the other side of those directions, the angle being determined by rotating the stage upon which the preparation lies. To facilitate the recognition of the precise azimuth in which the axes of elasticity lie, an axially-cut plate of quartz, having a thickness of 1-6″, is inserted between the object-glass and the analyzer, and the Nicols should be so adjusted that a uniformly violet light pervades the field. A known crystallographic edge being made to coincide with one of the spider-lines, the section is then turned, until a tint is established which exactly corresponds with the tint visible in the field of the microscope when the preparation is removed. Similar determinations may also be effected by stauroscopic methods, which are described in the works already cited. These means of ascertaining the position of the axes of elasticity, are of course applicable to any minerals which are translucent when cut in sufficiently thin slices. Tables of the angles of extinction in the different minerals will be found in various works on mineralogy.

Reverting to our section of granite, we may notice that there is perhaps more than one kind of mica present. One is probably of a more or less deep-brown colour, and the plane of the section may be either parallel with the basal planes of the crystals, thus affording six-sided forms, or it may cut through the crystals at some angle to the basal plane. In the latter case it will be found, that by rapidly rotating the polarizing prism, the analyzer being removed, a marked change of colour or tint occurs, while, if the mica be colourless, there will merely be a slight change in the intensity of the light transmitted under similar conditions. The brown, or in hand specimens often black, mica is commonly Biotite, the colourless mica, Muscovite; but there are many other species of mica, and in order to know which species is present, it may be needful to have recourse to blowpipe analysis or to an examination of cleavage plates, or of sections coincident with the basal plane, in convergent polarized light. For this purpose two or more strongly converging lenses are placed above the polarizer, and are brought just beneath the preparation. A wide-angle half- or quarter-inch object-glass should be used in conjunction with an eyepiece-fitting without lenses, surmounted by an analyzer; or better, the arrangement introduced by Swift, of University Street, Tottenham Court Road; in either case, the Nicols being accurately crossed. To determine the positive or negative character of the crystal, a quarter-undulation plate, or a quartz-wedge, should be employed; but the manner of using it and the phenomena observed under these conditions must be looked for in books specially devoted to such questions. Again, in a thin section of granite, the observer will also notice the presence of more or less quartz. This will appear colourless and limpid by ordinary transmitted illumination, but in plane-polarized light it will exhibit strong colours; and in convergent light it will, if of suitable thickness, show a more or less perfect interference-cross. The rotatory polarization of quartz cannot be observed in ordinary microscopic rock-sections, which are far too thin to permit this phenomenon.

Quartz, when examined under moderately high powers, is usually seen to contain lacunæ partially or wholly filled with fluid, which is very commonly, but not always, water. In the partially filled cavities, bubbles of course exist, the size of which in relation to the size of their containing cavities represents the condensation which the liquid has undergone since its imprisonment. On the application of heat the bubbles contract. The cavities vary greatly in form; those shown in Pl. 42. fig. 1 are unusually large. The bubbles in these lacunæ sometimes exhibit spontaneous motion when high powers are employed.

Pl. 42. fig 10. represents part of a section of Syenite. In this rock, hornblende is one of the essential constituents. In one of the patches of hornblende there figured, the characteristic cleavages are shown, intersecting at an angle of about 125°. These cleavage-planes run parallel with the faces of the oblique rhombic prism. In augite, the corresponding cleavage-planes intersect approximately at right angles. Hornblende may also usually be distinguished from augite by its dichroism, which becomes evident when the lower Nicol is rotated, the analyzer being removed. Augite shows, as

a rule, no dichroism. Augite is a common constituent of Basalt and other rocks of a basic character. Fig. 18 shows a section of a crystal of augite cut transversely to the principal axis. In fig. 14 are shown the very peculiar forms of hornblende, which occur in some phonolites, and which from their frayed-out ends can sometimes hardly be recognized as crystals. In fig. 15 some more hornblende is shown, occurring in a diorite; the character of the twinning in the triclinic felspar is shown in this drawing. It is in the nature of the felspar that diorite differs from syenite. The original syenite of Pliny, from Syene in Egypt, contains quartz. Many petrologists, however, now exclude from syenite those rocks in which quartz is present. The quartzless syenites are closely related to minette (Pl. 42. fig. 11), in which magnesian mica takes the place of hornblende. The crystals of mica constitute the chief features of the rock. The matrix in which they lie is a finely crystalline mixture of felspar and mica. In the drawing, the central crystal of mica is cut transversely to the basal plane: the fine striæ representing the direction of cleavage or the characteristic platy structure of mica. A crystal of magnetite is also shown in this drawing. It is a section through an octohedron. Among the minerals which crystallize in the cubic system, Haüyne and Noseau are often met with in volcanic rocks. In Pl. 42. fig. 14 some crystals of Noseau are shown; like all cubic minerals, they exert no influence upon polarized light. Haüyne and Noseau exhibit structural peculiarities when examined under high powers, which cannot be described or figured in this short article. Fig. 16 represents a crystal of Olivine in a Saxon basalt. Olivine is a common constituent of basalt, and some modern petrographers exclude from basalt any rock from which olivine is absent: thus many of the rocks which in England have always been regarded as basalts, would under this new arrangement be classed with the andesites. Olivine being a rhombic mineral, has its axes of elasticity coincident with its crystallographic axes. Fig. 17 represents a section of basalt from the Giant's Causeway, as seen by polarized light under an amplification of 77 diameters. The black patch in this drawing indicates magnetite or titaniferous iron, both of which minerals are commonly more or less plentiful constituents of basalt. Pl. 42. fig. 15 shows a transverse section of a crystal of Nepheline partly filled with dusty matter. Nepheline is sometimes met with in basalts; this drawing is made from a phonolite. The phonolites are rocks which essentially contain nepheline. The green crystals in the drawing are microliths of hornblende.

The rocks Diabase and Gabbro may be regarded as varieties or special conditions of basalt. The latter rock contains diallage instead of augite; but these two mineral species are now regarded by some mineralogists as identical.

The rocks termed Norite and Hypersthenite, contain the rhombic forms of pyroxene, hypersthene, and enstatite. Fig. 13 is drawn from a section of trachyte and shows crystals of sanidine and oligoclase, the former a monoclinic, the latter a triclinic felspar. In the centre is a crystal of sphene or titanite, which although not a very common rock-forming mineral, nevertheless occurs both in plutonic and volcanic rocks.

We now come to rocks of a different class to those just described. These are known as *metamorphic*; and they are regarded by some as the result of the alteration of sedimentary rocks by high temperatures existing at great depths beneath the surface of the earth, or by the contact or proximity of eruptive rocks. Others regard them in many cases as the result of crystallization from solution, and not by fusion, set up in sedimentary rocks subsequent to their deposition. Whatever may have been the processes by which they have arrived at their present condition, we find that they consist of minerals which, in the main, are identical with those which are met with in eruptive rocks: thus, gneiss for example, is identical with granite so far as its mineralogical constitution is concerned; but the crystals and crystalline grains which compose the rock, are arranged in more or less definite layers of different mineral character, an arrangement termed foliation. Mica-schist (Pl. 42. fig. 20) is another example of a metamorphic rock, and consists essentially of rudely alternating layers or films of mica and quartz. Chlorite-, talc-, schorl-, and hornblende-schists are rocks of similar structure, and contain respectively the minerals which their names imply, together with quartz, and at times felspars, garnets, &c., while staurolite, chiastolite, &c. are met with in certain argillaceous rocks which have also been subjected to alteration. Quartzite again is an altered sandstone, and the bedded hälleflintas of Scandinavia (Pl. 42.

fig. 12) are usually regarded as altered felspathic sandstones, which are identical in mineral constitution and structure with the rocks known as felstone, which consist of a micro-crystalline admixture of felspar and quartz, and in which the boundaries of the component grains are not always clearly defined under the microscope. This hazy ill-defined granular structure is spoken of as a crypto-crystalline one; while there is also another condition of matter having the same chemical composition in which merely a nebulous, granular, or faintly-marked fibrous structure distinguishes it from vitreous substances, its optical character being similar to that of glass. This is known as microfelsitic matter.

The four drawings which constitute the lower row in Plate 42 represent *sedimentary* rocks, or those which have resulted from the disintegration of preexisting land, the degraded materials having been transported by rivers and deposited in the sea or in lakes. Sandstones, shales and slates, and limestones, may be regarded as the principal types of these sedimentary deposits. Pl. 42. fig. 21 represents a section of millstone grit as seen under polarized light. The rock consists essentially of fragments of quartz with some fragments of felspar, bound together by a ferruginous cement. The fragments have probably resulted from the disintegration of granitic rocks, the mica, owing to its form rather than its specific gravity, having been held longer in suspension, and transported to greater distances in the old seas in which these materials were deposited. Pl. 42. fig. 22 represents a piece of Cambrian slate from the Penrhyn quarries in N. Wales. The appearance is that presented between crossed Nicols. The general elongation of the constituent particles in the direction of cleavage, is the result of pressure, which is further demonstrated by the frequent distortion of the fossils met with in these old deposits. Microliths are also present which have been developed subsequently to the deposition of the rock. Similar microliths in other Palæozoic slates have been referred by Kalkowsky to andalusite, a silicate of alumina. Pl. 42. fig. 23 shows the small spheroidal grains which occur in the Great Oolite of Lincolnshire. They are concentric deposits of carbonate of lime, which often, as in the largest spheroid in the figure, have a foraminifer as a nucleus; in some cases the accretions have taken place around a grain of sand. The interstitial matter in these rocks is usually crystalline carbonate of lime. Pl. 42. fig. 24 is an example of a crystalline, saccharoid limestone, statuary marble. It consists wholly of crystalline grains of calcite. The twinning of the separate crystals, parallel to a rhombohedral face, is represented as it is seen by polarized light.

It is impossible in this article to cite further examples. Volcanic ejectamenta, which both in their loose and consolidated states, offer problems of great interest to the geologist, must pass unnoticed; but, before closing this article, it may be worth while to make a few remarks on the relative merits of thick and thin microscopic sections of rocks. In the first place thick sections are easier to prepare; but in most cases they are of little or no use to the student, since the optical properties of the different minerals cannot as a rule be properly studied from such feebly translucent preparations. The rotatory polarization of quartz can of course only be observed in thick sections taken at right angles to the optical axis; and dichroism, when barely perceptible in certain thin slices, becomes well marked in thicker ones; but apart from these advantages which thick sections possess, they have others. A thick unmounted section can be submitted to the action of chemical reagents, and in many cases may be subsequently washed, ground thinner, and finally mounted, while much useful information may be thus gained. Little objection can also be raised to thick sections of vitreous rocks, when they happen to be very transparent, since the crystals which they contain may then be studied in their integrity; whereas in thinner sections we can merely examine slices of them. Furthermore, in the preparation of very thin sections there is always the danger either of stripping out the larger crystals, or of ultimately wasting labour by grinding away the whole of the preparation. Thick sections are best examined by reflected light, when many important points are often discerned, which would never be noticed if transmitted light only were employed. As a rule, however, it is scarcely possible to prepare too thin a section of a rock, nor to over-estimate the value of the thinnest preparations which can be procured; since a few finishing touches may often permit the recognition of structure which would otherwise pass unnoticed. Most of the lapidaries in this country spoil their sections

through not risking their loss or diminution of size by those finishing strokes which render a preparation useful or worthless. The best sections I have yet seen are those prepared by Cuttel, of New Compton Street, Soho. Good rock-sections may also be procured on the continent, notably from Voigt and Hochgesang of Vienna, Marchand of Paris, and Fuess of Berlin. Machines for the preparation of rock-sections are made by Cotton and Johnson of Grafton Street, Soho, Fuess of Berlin, and others. Much may, however, be done simply with a flat cast-iron plate and emery, while a file and hone will suffice for the preparation of some of the softer rocks. Chapters on this branch of microscopical work will be found in 'The Study of Rocks,' and in Beale's 'How &c.' Microscopes suitable for this branch of study, are made by Watson, of 4 Pall Mall, and Swift, of University Street, Tottenham Court Road.

The student of petrology should, however, study the great features presented by rock-masses, and learn to recognize the large crystals, with which Nature and the mineral-dealer can provide him, before he commits himself to microscopic investigation.

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Numerous papers on Microscopic Mineralogy and Petrology, by Phillips, Sorby, Allport, Bonney, Ward, Davis, Daintree, and others, will be found in the *Qu. Jn. Geol. Soc.*, others in the *Jn. Mic. Soc.*, *Tr. Roy. Soc. Ed.*, the *R. Irish Academy*, the *Roy. Irish Geol. Soc.*, *Neues Jahrb. f. Mineral., Zeitsch. d. deutsch. geol. Gesellsch.*, *Bull. d. l. Soc. Minéral. d. France*, &c.

RŒSTE'LIA, Rebent.—A genus of Uredinei (Coniomycetous Fungi), closely related to ÆCIDIUM, and presenting similar spermogonia and perithecia; the chains of spores of the *Rœsteliæ*, however, present a peculiarity,—having a sterile joint, forming an isthmus of variable length, between each spore: the peridium bursts irregularly; or (in *R. cancellata*) the teeth cohere more or less for a time, so as to form a kind of lattice. This genus includes *Æcidium cornutum, laceratum*, and *cancellatum* of older authors, growing respectively on the leaves of the mountain-ash, hawthorn, and pear. See ÆCIDIUM and UREDINEI.

ROOTS.—The structure of roots presents important modifications; but these are less striking than those in stems. In all cases they have a fibro-vascular axis enveloped in a more or less thick cortical parenchyma, covered when young by a delicate epidermis devoid of stomata (epiblema), when old by an epidermal tissue of corky nature.

The roots of the vascular Cryptogamia are all adventitious; and their structure consists merely of a central fibro-vascular axis, surrounded by a cellular cortex and an epidermis provided with root-hairs of a yellowish colour.

Dicotyledons produce an axial root, which is a direct prolongation of the stem downwards; and both this and the adventitious roots frequently developed on the stem have the peculiar unlimited fibro-vascular structure found in the stems of this class, and may become woody and increase by annual layers like the ascending axis. The axial root of Dicotyledons, being a direct continuation of the stem, displays a circular group of fibro-vascular bundles as in the ascending axis; but these mostly converge at the point of junction of stem and root (collar), so that the central axis of the parenchyma, the pith, is usually absent, the medullary rays remaining as in the stem. Externally, again, there is a difference, since the liber-bundles vanish and the cambium-region passes at once into the cortical parenchyma, here colourless and succulent, and this is clothed by a less prominent peri-

derm than the stem. The roots of Dicotyledons increase in diameter by annual layers of wood formed in the fibro-vascular bundles; these, however, are much less regular in their arrangement than those of the stem on account of the tortuous course of the roots; hence, while the wood of the roots is often useful for ornamental purposes, it is comparatively valueless for carpenters' uses. The branches of the axial root are originally growths from the apex of the root thrown off to the sides as it were, and their woody axis is derived from a division of that of the main root. The radical of a germinating Dicotyledon has its pileorhiza, and grows, in the same way as that of the Monocotyledons, by development of cells just behind the apex. Young roots are covered by a delicate epidermis; and the cells of this are abundantly produced into hairs (fibrillæ) in many plants, especially in those growing on light soils; these fibrils are deciduous, the delicate epidermis, which is always destitute of stomata, being gradually converted into a corky layer. Adventitious roots are very common in Dicotyledons, especially the herbaceous perennial kinds, and they alone can exist on plants raised from cuttings &c. of stems. The roots originate much in the same way as those of the Monocotyledons, appearing first as cellular cones in the region adjacent to the cambium-layer, with which the fibro-vascular structure soon becomes confluent. They break through the rind with a coleorhiza, and protected by a pileorhiza, just as in Monocotyledons; but when once formed, they appear to branch in the same manner as the axial root, and not by the formation of secondary adventitious roots.

The radicle of a monocotyledonous embryo is never developed; but if a section is made of the lower part of the embryo, we find one or more little conical bodies imbedded in the parenchyma; these are the nascent adventitious roots, which soon appear externally, breaking their way through the superficial tissue. The anatomy may, however, be more easily studied by tracing the development of the adventitious roots on the rhizomes of rushes, flags, and other plants of this class. The roots originate in the region where the fibro-vascular bundles of the stem terminate, (and frequently form a fibrous plexus). They are first wholly cellular, and consist of three parts:—a woody axis which soon becomes continuous with the fibro-vascular plexus; a cortical parenchyma, continuous with the inner part of that of the parent stem; and a kind of conical hood of rather dense cellular tissue enveloping the end of the root. As the root grows it pushes the hood forward, which breaks down the cellular tissue before it, and finally appears externally. When the epidermis is ruptured in this way, it presents a circular free edge standing up slightly like a collar around the base of the free part of the root: this is called the coleorhiza by some authors. The conical hood upon the apex of the root, called the pileorhiza, is more or less persistent in different cases; in aquatic plants it becomes greatly developed, as may be seen in the duckweed (*Lemna*), where it forms a long sheath, appearing as if slipped over the end of the rootlet. The focus of development of the root is within the pileorhiza, which is pushed forward by the continued development of cells just behind the apex. The pileorhiza may be compared to a kind of shield or guard to the tip of the root, protecting the nascent tissue, by the expansion of which it is pushed forwards, itself always possessing a certain solidity, which enables it to penetrate between the particles of the soil.

The centre of the root of a Monocotyledon is occupied by prosenchymatous tissue with a circle of vessels around it, the whole enclosed by regular parenchyma, sometimes by liber-cells and covered by an epidermis. The ring of vessels spreads out into a kind of rosette at the base, and anastomoses with the extremities of the fibro-vascular bundles of the stem in the fibrous region. Secondary adventitious roots are formed in the same way in the roots, originating immediately upon the vascular ring and breaking through the cortical parenchyma. The woody adventitious roots of arborescent Monocotyledons differ only in the greater development of the fibro-vascular structures; and they emerge from the stem (palms) in the form of thick conical shoots. In the thickened adventitious roots of asparagus, which perform the function of tubers, the parenchyma is greatly developed. In the tuberous roots of Orchids the central woody axis becomes irregularly expanded into parenchymatous tissue, driving the vessels out nearly to the periphery, so that the characteristic structure is greatly disguised. The aërial roots of the epiphytic Orchids have the growing extremities clothed by several layers of a parenchy-

matous tissue, in which the cells are characterized by delicate open spiral-fibrous secondary layers.

Roots grow by cell-development only near the apex; and interstitial expansion soon ceases. Old roots of Dicotyledons present a dense heart-wood like the trunks, the passage of fluid taking place through the outer layers. When the older parts of roots are exposed to the air by removal of soil, they acquire a thick corky periderm. The general structure of the root of Conifers is like that of Dicotyledons.

Bibl. Henfrey-Masters, *Bot.*; Nägeli and Leitgeb, *Näg., Wiss. Bot.* 1867; Hofmeister, *Morphol. d. Geweb.* 1865; Tieghem, *Ann. Sc. N.* 5. xiii.; Sachs, *Bot.* 165; Olivier, *Rac. tég.* 1882 (50 pls.).

ROTA'LIA, Lamarck (restricted).—A typical Foraminifer; shell ammoniform, neat, finely porous, unequally biconvex; with 13–40 chambers, double septa, and canal-system; limbate and often granulate.

Species numerous, both fossil and recent (*R. Beccarii*, Pl. 24. figs. 13, 14).

Bibl. Carpenter, *For.* 212; *Micr.* 545; Parker & Jones, *Phil. Tr.* clv. 387.

ROTALI'NA, Carpenter (*Rotalinæ*).—A subfamily of *Globigerinida*. See Foraminifera.

Bibl. Carpenter, *For.* 198; Parker & Jones, *Phil. Tr.* clv. 378, and *Qu. J. G. S.* xxxviii. 103.

ROTATION or CYCLOSIS.—This term is usually employed in botanical works to denote peculiar flowing movements of the contents of vegetable cells; and it is useful to retain the word for all cases of the kind, in order to avoid confusion of these phenomena with the general circulation of the sap. The term "circulation of the cell-sap" is, however, often used instead of rotation, and especially in reference to the cases where it exhibits numerous distinct currents.

The rotation presents itself in two types, namely—(1) a rotatory movement of a layer of protoplasm investing the entire internal surface of the cell, as in Chara, &c.; and (2) a radiating movement of the protoplasm in slender currents, from the nucleus out over the remainder of the cell, with a return flow towards the nucleus; but as the nucleus itself shifts in the latter type as in the former, the two kinds are scarcely definitely distinguishable; they may, however, be spoken of separately.

The rotation in *Chara* and *Nitella* has been long known; a similar movement occurs in many water-plants, such as *Vallisneria, Hydrocharis, Anacharis, Stratiotes, Sagittaria, Potamogeton, Ceratophyllum*, &c., where it is seen best in the more delicate foliaceous structures, such as young leaves, stipules, or sepals, or in the young rootlets. It has also been observed in the fruit-stalks of *Blasia pusilla* and some other Hepaticæ.

In the Characeæ the wall of the cells is lined with chlorophyll-granules, leaving two oblique or spiral striæ bare (fig. 125, p. 162); these striæ indicate the boundaries of the ascending and descending currents (marked by arrows). The moving substance is a viscid semifluid layer, lying within the chlorophyll-layer, and itself surrounding the watery cell-sap occupying the centre of the cell. This layer, forming a kind of gelatinous sac, moves in a spiral course up one side of the cell and down the other, the motion being rendered very evident by chlorophyll- and other granules imbedded in it; these appear to be carried along passively by the stream, the larger slowly, the smaller with greater rapidity. In *Vallisneria, Anacharis*, &c. the chlorophyll-granules and the nucleus are imbedded in and moved with the flowing protoplasm. If long cells of *Chara* are bent or tied round by a ligature, the circulation is not stopped, but takes place independently in each half. If a cell of *Chara* is cut across, the protoplasm of the current flowing towards the cut surface escapes at once, but that of the current flowing away, goes on to the end of the cell, turns round, and then flows towards and out from the wound.

The size of the stream seems to be in inverse proportion to the length of the cell, decreasing as the latter acquires its full development. The rapidity of the current varies according to the age of the plant and the activity of its vegetation. It is most rapid in hot weather and in sunshine. Artificial elevation of temperature in the water in which the plant grows, up to a certain point, hastens the movement; a heat above 80° Fahr., however, retards it for a time. A temperature of 112° Fahr. kills the plant, as also does a cold of about 20°. Darkness appears merely to exert effect through its influence on the activity of the vegetation. Keeping *Chara* in water exhausted of air does not stop the rotation until the plant dies. Most chemical reagents seem to exert no special action; only lime-water appears to stop it in a few moments. A solution of sugar, or gum, or milk greatly hastens the

rotation in *Vallisneria*, so that the protoplasm is moved on in waves; but the primordial utricle finally dissolves, and the movement ceases. Passing an electric current through the cell stops the current for a time; but it recovers itself, just as occurs after any mechanical interference. If several cells are injured by cutting or pricking, the whole rotation stops in young plants, but it gradually returns as before in the uninjured cells. Pressure interrupts or stops the motion for a time only; when removed, the current is gradually restored; but actual injury to the cell stops it for ever.

The rotation which takes place between the external surface of the green layer and the outer cell-membrane in *Closterium* and other DESMIDIACEÆ appears to be of the same kind as the above.

The circulation in reticular currents, first observed by Brown in the hairs of the stamens of *Tradescantia*, appears to exist far more extensively, if it be not even a universal phenomenon. It has been observed in the Confervoideæ, Fucoideæ, Florideæ, Lichens, Fungi, Hepaticæ, Equisetaceæ, Lycopodiaceæ, and Ferns, and in the most varied families of Flowering plants. It is seen most easily in young tissues, especially such as can be prepared readily without much mechanical injury; for example, in hairs, cells of the pulp of fruits, cells of the germen of Onagraceæ, of the labellum of Orchids, &c. It generally exhibits the following characters:—In the middle or at one side of the cell occurs a large heap of protoplasm, in which is imbedded the nucleus; from this protoplasm more or less slender filaments run out over the cavity of the cell, and as these contain numerous fine granules, a flowing movement which takes place becomes evident by the change of place of the granules. Attentive examination shows that these flow out from the central mass and return to it, and, moreover, that the currents change their form and direction, and, lastly, that the nucleus itself moves. This rotation cannot be observed in very young cells when the cavity is densely filled with protoplasm; but Hofmeister states that he has seen the entire primordial utricle rotate in the special parent cell of the spore of *Phascum cuspidatum*. As the young cells increase in size, vacuoles are formed in the protoplasm, filled with watery sap; and these enlarging and becoming confluent, leave the protoplasm in the form of a reticulated mass.

The cause of the motion is evidently related to the movements exhibited by free protoplasmic bodies, such as ZOOSPORES, SPERMATOZOIDS, the free filaments of OSCILLATORIA, &c. It has been well compared with the movements of the body of *Amœba*, which bear considerable resemblance to some kinds of the reticular rotation. The relation existing here is further borne out by the fact of pulsating vacuoles existing in *Volvox*, *Gonium*, &c., just like those in the Infusoria.

The actual rotation or movement in a definite direction is the result of the confining cell-wall on the contracting and expanding protoplasm. It is produced in Algæ during cell-growth.

The rotation in *Chara* may be observed by simply placing portions of the plant on a slide in water. The unincrusted species are of course most favourable; but the growing points of the others are tolerably transparent. In *Vallisneria*, detached fragments of leaves, or even horizontal sections of the leaf, may be used; in *Anacharis*, entire leaves or sepals may be detached and observed. Hairs are frequently more or less covered with a viscid secretion, which retains air-bubbles about them; in such cases, it is often useful to dip them for an instant in alcohol, and then place them in water.

BIBL. Varley, *Tr. Soc. Arts*, xlviii.; *Mic. Trans.*; Slack, *Tr. Soc. Arts*, xlix.; Dutrochet, *Compt. Rend.* 1837, 775; Becquerel, *ibid.* 784; Unger, *Sitzungsber. Wien. Ak.* viii. 32; Mohl, *Bot. Zeit.* iv. 73; *Ann. N. H.* xviii. 1; Hofmeister, *Very. Unters.* 73; Osborne, *Mic. Jn.* iii. 54; Branson, *ibid.* iii. 260; Wenham, *ibid.* iii. 250; Henfrey, *Ann. N. H.* 3, i. 419; Reichert, *Ann. N. H.* 1867, xix. 10; Beale, *How &c.* 4th edit. 165; Carpenter, *Microscope*; Henfrey-Masters, *Bot.* 551.

ROTATO'RIA or ROTIF'ERA. — A Class of the ANIMAL KINGDOM.

Char. Microscopic, transparent animals, living in fresh or in salt water; legs absent; anterior portion of the body furnished with one or more retractile, often lobed disks, upon which are placed usually vibratile cilia, when in motion presenting the appearance of one or more revolving wheels; alimentary canal usually distinct, with a dental apparatus, and two orifices; reproduction by ova.

Body covered with a firm and usually smooth skin or integument, sometimes pre-

senting indications of segments; often more or less enclosed in a carapace (CARAPACE), which is either secreted by the skin, by the alimentary canal, or by a special secreting organ. In some species the skin is furnished with cilia, hairs, or rigid bristles.

In most, there is a tail-like process at the posterior end of the body called the foot-like tail, tail-like foot, or false foot; this is jointed, and can often be contracted and extended like a telescope; it does not form a direct prolongation of the end of the body, but arises from and is situated upon the ventral aspect. It is often terminated by a suctorial disk, or a pair of claw- or toe-like processes.

Distinct longitudinal and circular muscular bands are present; and they sometimes present transverse striæ.

The rotatory disks or wheel-organs vary greatly in structure, the varieties forming characters of the families and genera.

Their margin is usually furnished with one or two rows of vibratile cilia; sometimes these are replaced by bundles of non-contractile elongate cilia (Pl. 43. fig. 32), or the rotatory organ is divided into tentacle-like processes, upon which cilia are placed (Pl. 44. fig. 25).

The rotatory disk is the principal organ of motion, by means of the cilia of which the animals swim through the water; some of the Rotatoria, however, move in a leech-like manner, by alternately fixing the toe-like processes and the anterior end of the body, which in some forms a kind of proboscis (Pl. 43. fig. 1).

The nervous system is not well known. It appears to consist of a ganglion and of branches given off in various directions.

In many of the Rotatoria, eyes are present, mostly red. These appear to have a cornea and a lens. They sometimes disappear in the adult animals; and as their number, position, &c. are used as characters, when absent in the adults, they must be looked for in the young or the ova, either within the carapace or adherent to the body.

Alimentary apparatus.—Behind the mouth is sometimes a distinct conical pharynx, but nearly always a rounded muscular gizzard containing the jaws and teeth. In the pharynx are occasionally seen two undulating lines, presenting a flickering appearance, the indications of cilia or undulating membranes. The jaws are constructed mostly after two forms. In one of these they consist of two knee-shaped pieces (Pl. 43. fig. 24),—to the posterior portion of which muscles are attached, whilst the anterior, which passes inwards at a right or obtuse angle to the former, ends in a single point or in several teeth (fig. 26). In the other, the jaws have the form of stirrups (fig. 17), with their bases turned towards each other, upon which two or more teeth are placed. A third single or compound intermediate piece forms a support (figs. 24, 26), upon which the food acted upon by the jaws is triturated. In some species the jaws and teeth are very complex in their arrangement.

The alimentary canal is usually short and straight, but sometimes curved. Its walls are very thick, and lined with ciliated epithelium. The stomach forms a distinct expansion (Pl. 43. fig. 27 *c*); this is succeeded by an intestine, the termination of which corresponds to a cloaca, receiving the expelled contents of the reproductive organs and so-called water-vessel system, and opening at the base of the foot. In some Rotatoria a second expansion or stomach is situated below the upper one.

The walls of the stomach and intestines frequently contain brown or yellow cells, representing a liver; and at the commencement of the stomach are two or more cæcal appendages, probably corresponding to a pancreas (Pl. 44. fig. 14).

In the male Rotatoria, the alimentary canal is entirely absent.

Vascular system.—Distinct blood-vessels are apparently not present in the Rotatoria; but on each side of the body, in most of them, runs a narrow straight or wavy band, containing a slender vessel (Pl. 43. fig. 18 *a*; Pl. 44. fig. 14 *b*). Anteriorly, these vessels give off branches, the terminations of which are not well known. By some they are said to open into the abdominal cavity, by others to terminate as cæca. Attached to the walls of these lateral tubes, or situated within them, are pear-shaped or oval corpuscles (Pl. 43. fig. 18 *a*; Pl. 44. fig. 14 *c*), which exhibit a flickering appearance from the action of cilia connected with them, and which open into the cavity of the abdomen. Posteriorly, the tubes terminate in an actively contractile sac, which opens into the cloaca. In regard to their function, these tubes have been variously viewed as water-vessels, testes, and kidneys. Ehrenberg considered them as connected anteriorly with a certain projecting organ (Pl. 44. fig. 14 *a*

situated usually in the cervical region (Pl. 43. fig. 3; Pl. 44. fig. 17), denominated the calcar or respiratory tube, and terminated by a retractile tuft of non-vibratile cilia (fig. 5 *a*). They have no relation, however, with this, which corresponds to an antenna. Huxley proved that they are part of a water-system.

Beneath the integument of the Rotatoria, a kind of irregular circulation, varying with the motions of the body, or a simple molecular movement of minute granules, has been noticed. These granules are probably situated in the abdominal cavity; in which also sarcodic globules, sometimes free, at others connected by filaments, have been observed.

Reproduction.—The Rotatoria are propagated by means of sexual organs, and are unisexual. The female organs consist of one or two longer or shorter ovarian sacs or ovaries, situated towards the posterior end of the body in the abdominal cavity, the oviduct terminating in the cloaca, or at a distinct vulva. The ova are of an oval form, and are sometimes smooth externally and soft. The winter-ova are larger and darker than those hatched during the summer, and the outer coat is thick and hairy or tubercular. The winter-ova which remain so long attached to the posterior part of the body are probably gemmæ; they sometimes remain adherent to the cloaca for a time, and in a few instances they are hatched within the ovary.

The testis is situated at the posterior part of the body, and consists of a wedge-shaped body, with a muscular duct opening externally.

Many of the Rotatoria are remarkably tenacious of life; and some of them are stated to have revived after having been kept dry for several years.

Perfect desiccation destroys the Rotifers, but they will last a long time with a very slight amount of moisture.

The families of the Rotatoria are thus distinguished:—

Ciliated margin of rotatory disk simple or continuous.
Margin entire. *Holotrocha.*
Carapace absent ..... Ichthydina.
Carapace present ..... Œcistina (?).

Margin undulate or excised. *Schizotrocha.*
Carapace absent ..... Megalotrochæa.
Carapace present..... Floscularieæ.

Rotatory disk divided or multiple.
Divided into several parts. *Polytrocha.*
Carapace absent ..... Hydatinæa.
Carapace present ..... Euchlanidota.

Divided into two parts. *Zygotrocha.*
Carapace absent ..... Philodinæa.
Carapace present..... Brachionæa.

See ALBERTINA.

They are found wherever water exists, provided it be not in a state of putrefaction,—thus in pools, on moist earth, mosses, in gutters, &c., and even in the cells of mosses and algæ.

BIBL. Ehr. *Inf.*; Dujard. *Inf.*; Siebold, *Vergl. An.*; Dalrymple, *Phil. Tr.* 1849, 331; Huxley, *Micr. Trans.* 1852, i. 1; Williamson, *Micr. Jn.* i. 1; Cohn, *Siebold und Köliker's Zeitsch.* vii. 431; Gosse, *Tr. Micr. Soc.* iii.; id. *Ann. N. H.* 1851, viii. 198 (several new genera and species); and 1856, xviii. 333; Pritchard, *Inf.*; Schmarda, *Neue Rotatoria*, 1861; Mecznikow, *Sieb. und Köll. Zts.* 1865; *Qu. Mic. Jn.* 1666, 34 & 240; Claparède, *An. N. H.* 1868, i. 309; Schloch, *Räderthiere*, 1869; Cubitt, *M. M. Jn.* vi. 168, viii. 5; Hudson, *M. M. Jn.* xiii. 45; Pascoe, *Zool.*

ROTIFER, Cuv.—A genus of Rotatoria, of the family Philodinæa.

Char. Eyes two, situated upon the proboscis; foot furnished with lateral horn-like processes, and with two terminal toes, giving its end a bifurcate appearance; fresh-water.

R. vulgaris (Pl. 44. fig. 23). Body fusiform, white, gradually attenuated towards the foot; length 1-48 to 1-24″.

This is one of the commonest of the Rotatoria, and has long been known as a favourite microscopic object under the popular name of the wheel-animalcule. The anterior and upper part of the body terminates in a proboscis, ciliated at the end, and upon which the eyes are placed; the two rounded lobes of the rotatory organ are placed laterally. Behind, and at the root of the proboscis, is the calcar.

In *R. citrinus*, the middle of the body is yellowish, the horns of the foot long, and the eyes round. In *R. macrurus*, the body is suddenly narrowed into a long foot. In *R. tardus* the body is gradually attenuated, but somewhat deeply constricted into segments.

BIBL. Ehr. *Infus.* 484; Pritchard, *Inf.*; Grenacher, *M. Mic. Jn.* 1870, 44.

ROTIFERA. See ROTATORIA.

RUBEFACTION OF WATER. See WATER.

RUCKERIA.—A genus of Compositæ. The pericarp possesses HAIRS of an interesting structure.

BIBL. Decaisne, *Ann. Sc. Nat.* 2. xii. 251; *Ann. N. H.* vi. 257.

RUEL'LIA.—A genus of Acanthaceous plants. The testa of the seed of *Ruellia formosa* exhibits a peculiar kind of HAIR (Pl. 28. fig. 21).

RUST OF PLANTS. See BLIGHT.

RUTILA'RIA, Gr.—A genus of Diatomaceæ. Frustules compressed, forming a short filament; valves elliptical, elevated at the angles, with a central nodule, terminating in two short processes; margin spinous. 3 species; in the Barbadoes deposit. (Greville, *Tr. Mic. Soc.* 1866, 124.)

RYE.—The grain of *Secale cereale.* See STARCH.

RYLAND'SIA, Gr. & Ralfs.—A genus of Diatomaceæ. Frustules simple, disk-shaped, areolar; valves with two opposite smooth rays, dilated at their base, not reaching the centre. *R. biradiata*, Barbadoes deposit. (Greville, *Qu. Mic. Jn.* 1861, 67.)

RYTIPHLŒ'A, Ag.—A genus of Rhodomelaceæ (Florideous Algæ), containing four British species, mostly common, having pinnately branched, filiform or compressed fronds, transversely striate and reticulated; the articulate axis is composed of a circle of large elongated tubular cells surrounding a central cell, the whole enclosed by a kind of rind of several layers of small coloured cells. Colour mostly dull red or brown. Fronds from 2″ to 4″ or 6″ high. *Ceramidia* scattered on the ramules of some plants; *antheridia* tufted in the same situations on others; and tetrahedral *tetraspores* occur imbedded in a double row in *stichidia*, borne on distinct plants. *R. pinastroides* (Pl. 4. fig. 11).

BIBL. Harvey, *Mar. Alg.* 80; Grev. *Alg. Br.*; Derbès and Solier, *Ann. Sc. Nat.* 3. xvi. 275; Thuret, *ibid.* 4. iii. 20.

S.

SACCAMI'MINA, Sars. See LITUOLIDA.

SACCOG'YNA.—A genus of Jungermannieæ (Hepaticæ) founded on *Jungermannia viticulosa* of Linnæus; it is remarkable on account of the subterraneous fleshy perianth, in which character and in habit it is allied to *Calypogeia.* It is found among mosses, especially in alpine districts.

BIBL. Hook. *Br. Fl.* ii. pt. 1. 121; *Br. Jung.* pl. 60; Ekart, *Syn. Jung.* pl. 1. fig. 6; Endlicher, *Gen. Pl.* Supp. 1. No. 472-23.

SAC'CULUS, Gosse.—A genus of Rotatoria, of the family Ichthydina.

Char. Eye single, frontal; body free from hairs, and without a foot; rotatory organ a simple wreath; alimentary canal very large; jaws set far forward, apparently consisting of two delicate unequal lateral pieces, and a slender central portion, very evanescent; eggs attached behind after deposition.

S. viridis. Length 1-150″; freshwater.

BIBL. Gosse, *Ann. N. H.* 1851, viii. 198.

SADLE'RIA, Kaulf.—A genus of Blechneæ (Polypodiaceous Ferns). Two species; arborescent; Sandwich Islands. (Hooker, *Syn. Fil.* 187.)

SAGENEL'LA, Brady.—A simple, branching, Arenaceous Foraminifer, attached to Nullipores, forming a network with its anastomosing branches (1-200″ to 1-65″ in diameter). Admiralty Islands. (Brady, *Qu. Jn. Mic. Sci.* n. s. xix. 41.)

SAGO.—Farinas obtained from a variety of tropical plants are known by this name; but the true East-Indian sagoes are extracted from the central part of the trunks of Palm-trees belonging to the genus *Sagus*, natives of the Moluccas. In Pl. 46. fig. 23, is figured the starch of a sago obtained from the Museum at Kew; but it is uncertain whether this is the produce of a *Sagus*; its grains resemble those of some East-Indian Arrow-roots (Pl. 46. fig. 18). See STARCH.

SAGRI'NA, D'Orb. (SAGRALNA, Reuss). See UVIGERINA.

SALA'CIA, Lamx.—A genus of Lafoëidæ, Hydroid Zoophytes.

Char. Stem erect, composed of aggregated tubes, branching, rooted. Cells cylindrical, sessile, without operculum, adnate for the greater part of their length, on all sides of stem and branches in regular longitudinal rows. Ovicells scattered on the stem and branches. Polypes long, cylindrical, with a conical proboscis.

S. abietina. Deep water off Northumberland coast. (Hincks, *Hyd. Zooph.* 211.)

SALICINE.—The alkaloid of the willow and poplar.

The so-called circular crystals of this substance (Pl. 39. fig. 9) form a beautiful polarizing object. The largest crystals are obtained by fusion.

SALICORNA'RIA, Cuv.—A genus of Cheilostomatous Polyzoa.

Char. Surface divided into rhomboidal or hexagonal spaces by ridges surrounding the cells; avicularia disposed irregularly.

S. farciminoides. On old shells, &c. from deep water, not uncommon.

BIBL. Johnston, *Br. Zooph.* 355; Busk, *Cat. Mar. Polyz., Brit. Mus.*, 16; Heller, *Verhandl. zool.-bot. Gesellsch. Wien*, xvii. 1867, 85; Hincks, *Polyz.* 104.

SALICORNARI'IDÆ.—A family of Infundibulate Cheilostomatous Polyzoa.

Char. Polypidom erect, branched, jointed; branches cylindrical, dichotomous, with the cells on all sides. One genus:

SALICORNARIA.

SALIVA and SALIVARY GLANDS.—These organs, consisting of the parotid, the submaxillary, and the sublingual glands, agree essentially in structure with the racemose mucous glands (MOUTH), of which they may be regarded as aggregations.

Their ducts consist of connective tissue, with numerous very dense networks of elastic tissue. Wharton's duct contains unstriped muscular fibres.

The salivary corpuscles are noticed at page 518.

SALMON-DISEASE. See ACHLYA.

SALPI'NA, Ehr.—A genus of Rotatoria, of the family Euchlanidota.

Char. Eyes single, cervical; foot forked; carapace closed on the ventral surface, and furnished with spines or horns at the ends. Freshwater.

The carapace resembles a three-sided box with convex sides, flat and closed beneath, and often scabrous.

S. redunca (Pl. 44. fig. 24). Carapace with two curved horns in front upon the ventral surface, smooth, posterior end with three horns; dorsum cleft, gaping. Length of carapace 1-216 to 1-144".

Five other species.

BIBL. Ehr. *Inf.* 469; Pritchard, *Infus.*

SALPIN'GIA, Coppin.—A genus of Cheilostomatous Polyzoa, of the family Eucratiidæ.

Char. Erect, branched; cells elongate, with spines and trumpet-shaped processes; orifice lateral. One species:

S. Hassallii. On filamentous *fuci*; rare.

BIBL. Coppin, *Ann. N. H.* 1848, ii. 273.

SALPINGŒ'CA, J. Clark.—A genus of Choano-Flagellate Infusoria. Single, in a fixed sessile or stalked, ovate or flask-shaped carapace. 29 species, marine and freshwater; attached to Algæ, shells, &c.

S. amphoridium (Pl. 53. fig. 25). Freshwater, on *Confervæ* &c.: length 1-3350". (J. Clark, *Mem. Bost. Soc.* i. 1868; Kent, *Inf.* 340.)

SALTS. See CRYSTALS.

SAL'VIA, L.—An extensive genus of Flowering plants, of the Nat. Ord. Labiatæ, including common sage, and many species cultivated for the beauty of their flowers. They are interesting to the microscopist both on account of the glandular hairs, containing the essential oils, and the spiral-fibrous structures found in the HAIRS of the pericarp (Pl. 28. fig. 23) and the hairs of the stigma.

SALVIN'IA, Mich.—A genus of Marsileaceæ, growing floating on the surface of stagnant water (not British).

The fructification resembles that of *Marsilea* and *Pilularia*, except that the antheridia and sporangia are contained in separate sacs, and also attached to a sort of central cellular stroma. The prothallium of *Salvinia* produces several archegonia. See MARSILEACRÆ and PILULARIA.

SAND, BRAIN-.—Brain-sand, or the acervulus cerebri, is found in the pineal gland and the choroid plexus, sometimes also in the pia mater, the arachnoid membrane, and the walls of the ventricles.

Fig. 623.

Brain-sand from the pineal gland, in bundles of areolar tissue.

Magn. 350 diams.

It consists of single, or aggregated and nodular, rounded, dark bodies, 1-2500 to 1-200" in diameter, sometimes also forming club-shaped, cylindrical, or reticular masses. It is principally composed of carbonate and phosphate of lime, and, like other concretions, leaves an organic cast of the original form, after the salts have been removed by a dilute acid.

BIBL. Kölliker, *Mikr. Anat.* ii.

SAND, SEA-.—This often contains interesting microscopic objects, as Foraminifera, spicules of sponges, minute shells of the Mollusca or their fragments, portions of the skeleton of the Echinodermata, &c.

The various bodies may be separated from the washed and dried sand with a mounted bristle.

The sand or powder which may be separated by pressing or shaking newly imported sponges, and which is sometimes

called sponge-sand, is very rich in the above organic bodies, especially the Foraminifera.

SANDSTONE. See ROCKS.

SAN'IDINE. See ROCKS.

SAP.—A name vaguely applied to the watery juices contained in living plants. Sap flowing from wounds may contain various organized substances, such as starch-granules, chlorophyll-globules, protoplasm, and also raphides; but it cannot be said to have any proper microscopic characters.

SAPROLEG'NIA. See ACHLYA.

SARACENA'RIA, Defrance.—A short, thick, triangular modification of *Cristellaria*. Recent and fossil. (Parker and Jones, *Ann. N. H.* 3. xii. 217.)

SAR'CINA, Goodsir.—A curious organism, formerly placed among the Palmellaceæ from considerations relating to its structure, but which, from its habitat and general characters, is now referred to the Schizomycetous Fungi. *Sarcina ventriculi* (Pl. 7. fig. 5 *a* and *b*) is sometimes found in great abundance in the vomited contents of the stomach of the human subject, also in the stomach after death, where no disorder had appeared during life. It consists of minute, cubical, oblong, or even irregular masses, of considerable consistence, composed of four, eight, sixteen, sixty-four or more, squarish cells contained in a tough transparent frond, apparently composed of the cell-membranes of these cells. The cells are always most closely connected in groups of four, which stand a little more apart from each other in the secondary groups of sixteen; these again have a stronger line of demarcation between them when they are collected into tertiary groups of sixty-four (Pl. 7. fig. 5 *a*, *b*). The size of the primary cells, or nuclei of Robin appears to vary slightly; we find their diameter about 1-16,000″; they have a slight brownish tint, which imparts a colour to the whole mass. Iodine colours the fronds brown; alcohol contracts them a little. Nitric acid does not dissolve them, even when heat is applied. Alkalies cause the fronds to break up into their constituent components. The plant appears to increase by the division of the contents of its ultimate cells into four and the formation of a new membrane around each portion, the groups remaining attached a longer or shorter time according to circumstances. Berkeley has in vain tried to get it to germinate in sugar and water.

It is stated to have been found also in the lung, and the pus of pulmonary abscess, the blood, the urine, the fæces, and in the stomach of the rabbit. According to Ferrier, it is normal or constantly present in the blood of man and animals; and may be readily obtained by keeping blood in tubes, stopped with wool, for a week or ten days, at a temperature of 100°.

We have never found it, except in the contents of the stomach.

Robin and Rabenhorst place *Sarcina* in the genus *Merismopædia*; but its cubical form and the absence of chlorophyll at once separate it.

BIBL. Goodsir, *Ed. Med. and Surg. Jn.* 1842, 430; *An. and Path. Obs.* 1845; Nägeli, *Einz. Alg.* 2; Robin, *Vég. Parasit.* 331; Rossmann, *Flora*, 1857, 641; Stephens, *Ann. N. H.* 2. xx. 514; Ferrier, *Qu. Mic. Jn.* 1872, xii. 163; Lorstofer, *Wien. Jahrb.* 1872.

SARCOCH'ITUM, Hass.—A genus of Infundibulate Ctenostomatous Polyzoa, of the family Alcyonidiidæ.

Char. Incrusting, covered with perforate prominences in which the cells are immersed; ova scattered singly throughout. One species:

S. polyoum. On *Fucus serratus*.

BIBL. Hassall, *Ann. N. H.* 1851, vii. 484; referred to *Alcyonidium*.

SARCODE.—A term applied by Dujardin to the gelatinous, homogeneous, diaphanous proteine substance occurring abundantly in very young animals, the larvæ of insects, embryos of the Vertebrata, worms, zoophytes, &c.; it is synonymous with protoplasm. It constitutes the whole of some of the lower animals, as the *Amœbæ*. It may be readily studied when exuding from around the body of the intestinal parenchymatous worms, as *Distoma*, *Cysticercus*, *Tænia*, &c., or almost any of the Infusoria, placed alive in water between two plates of glass. In the course of a short time, the bodies of the animals are seen to be bordered with a row of projecting diaphanous globules (Pl. 32. fig. 2 *a*), frequently more or less pressed together, which after a time become separated and float in the liquid, especially if it be shaken. Spherical cavities or vacuoles are soon perceptible in these globules of sarcode (Pl. 32. fig. 2 *b*), the nature of which is readily determined by comparing the refraction of the light at their circumference with that at the circumference of the globules themselves; for on elevating the object-glass, the centre of the

vacuoles becomes darker, and the centre of the globules becomes brighter; whilst on approximating the object-glass, the reverse takes place. The spontaneously produced cavities continue to enlarge and increase in numbers, until some of the globules appear perforated in all directions. Ultimately the globules become so altered by the action of the water, that they form a thin granular or wrinkled layer, resembling coagulated albumen.

The protoplasm of vegetable cells corresponds to the sarcode of animal structures. In certain cells it exists in two forms as regards density, the outer portion being firmer than the inner; or it may become entirely liquid. In many of the lower organisms, and probably most cells in their youngest state, it is glutinous, and in the former, permanently remains so.

When existing in cells and the lowest animals, it appears to constitute the essential part of their structure, and is capable of performing all the functions carried on by the tissues of the higher or more perfect organisms. It also appears that the cell-theory, in so far as it attributes the principal importance to the cell-wall, is founded upon error—the cell-wall merely forming a protection to the sarcode or primordial utricle of plants, and the sarcode, or protoplast as it might be called, of animals, enabling them to carry on their essential functions uninterrupted by surrounding influences (1st Ed. 1856).

Bibl. Dujardin, *Infus.* p. 35.

SARCONYS'SUS, Kol.—A genus of Ixodea, with the terminal joint of the palpi rounded or oval; 4 species; on bats. (Kolenati, *Sitz. Ak. Wien*, 1860, 576; Murray, *Ec. Ent.* 195.)

SARCOPSILLUS, Westw.—A genus of Aphaniptera. One species, on the fowl. (Westwood, *Ent. Mn. Mag.* 1875, xi. 246.)

SARCOP'TERUS, Nitzsch.—A subgenus of *Sarcoptes*. In the two anterior pairs of legs, the suckers are replaced by claws, and in the posterior by hairs. *S. nidulans*, in birds. (Murray, *Ec. Ent.* 314.)

SARCOP'TES, Latr.—A genus of Arachnida, of the order Acarina, and family Acarea.

It is, by some authors, considered a family, being divided into several genera, as *Sarcoptes*, *Symbistes*, *Sarcopterus*, *Myobia*, *Otonyssus*, *Listrophorus*, *Myocoptes*, and *Dermaleichus*.

S. scabiei (*Acarus scabiei*, Pl. 6. fig. 16); the itch-insect of man.

Body soft, white, oval-oblong or rounded; ventral surface with transverse and undulating rugæ; dorsal surface with marginal irregularly concentric rugæ, the central space with numerous short and conical papillæ and stouter but short protuberances or spines arising from an annular base; at the sides and upon the surface of the body are also scattered setæ. Head small, somewhat narrowed in front; mandibles toothed. Anterior two pairs of legs separated from the posterior by a considerable interval; legs short, the anterior two pairs with acetabula or adhesion-disks and five-jointed, the posterior three-jointed, the last joint terminated by a long seta and without acetabula. Length of female 1-100 to 1-75″.

The females burrow in the skin, in which the oval eggs, 1-120″ in length, are laid; these are hatched in about ten days, and the young have only six legs.

Male only about half the size of the female, and with acetabula to the hindermost pair of legs.

The irritation produced by these mites and their ova is the cause of the itch.

They should be searched for at the end of one of the red streaks or burrows, which are often visible to the naked eye; the ova are frequently present in the pustules. They are most easily found by examining the skin with a power of fifty to seventy diameters, attached to a firm but moveable arm, and with the aid of a good bull's-eye condenser.

The entire animals may be preserved in glycerine or solution of chloride of calcium; the parts of the mouth should be dried and mounted in Canada balsam.

Other varieties or species occur upon animals, as the dromedary, the chamois, the dog, sheep, rabbit, &c.

Bibl. Bourguignon, *Traité de la Gale* (abstract in *Ed. Monthly Journ.* 1852, lx.); Gervais, *Walckenaer's Insect., Apt.* iii. 268, and *Ann. Sc. Nat.* xv. 9; Hering, *Krätzmilben d. Thiere*, *Nov. Act.* xviii. 573; Dugès, *Ann. Sc. Nat.* 2. iii. 245; Fürstenberg, *Krätzmilben*; Murray, *Ec. Ent.* 291; Mégnin, *Paras.* 158.

SARCOS'CYPHUS, Corda.—A genus of Jungermannieæ (Hepaticæ). *S. Ehrharti* (*Jung. emarginata*, Ehrh.) is a remarkable species, of dark purple, almost black colour, growing frequently in wet places, on rocks of mountainous districts.

Bibl. Hook. *Brit. Flor.* ii. pt. 2. p. 114; *Brit. Jung.* pl. 27; Ekart, *Synops. Jung.*

pl. 7. fig. 56, and pl. 13. fig. 113; Endlicher, *Gen. Plant.* Supp. i. nos. 474–1.

Fig. 624. Fig. 625.

Sarcocyphus Ehrharti.

Fig. 624. Perichæte and perigone opened, showing the young sporange emerging from the epigone. Magnified 25 diameters.

Fig. 625. Perichæte and perigone opened, showing the base of the seta surrounded by the epigone. Magnified 10 diameters.

SARGAS'SUM, Ag.—A genus of Fucaceæ (Fucoid Algæ), gulf-weeds, known from the allied sea-weeds by its stalked globular air-vessels. The receptacles are small, linear, and mostly clustered at the base of branches, and pierced by numerous pores leading to *conceptacles*, containing spore-sacs and clusters of antheridia (see FUCACEÆ).

BIBL. Harvey, *Brit. Mar. Alg.* p. 14, pl. 1 A; Greville, *Alg. Brit.* pl. 1.

SCALARIFORM VESSELS. See SPIRAL STRUCTURES.

SCALES OF FISHES.—These bodies were formerly regarded as epidermic formations, analogous to the nails, &c. of the higher animals, which later observations have shown not to be the case.

Each scale is contained in a distinct sac of the skin or cutis, covered externally with its pigment-layer and epidermis. The cutis itself consists of interlacing fibres of areolar tissue with formative cells. The pigment-layer is composed of elegant pigment-cells with long processes. Immediately above the upper surface of the scales lies a very fine membrane, distinct from the cutis, in which the impressions of the irregularities of surface existing upon the scales are visible.

In some fishes, as the eel, the scales do not project beyond the surface; hence the eel is commonly supposed to possess no scales. They are easily seen, however, in a dried piece of the skin, mounted in balsam, covered by the skin with its pigment-cells (Pl. 22. fig. 19), the whole forming a very beautiful object.

In many of the common cycloid fishes, as the roach, dace, &c., the scales project posteriorly from the surface, carrying before them the thinner and closely applied outer layer of the cutaneous sac, whilst the anterior portion of the sac extends into or is formed by the under portion of the cutis. In these fishes also, the portion of the cutis situated beneath the posterior projecting portion of the scales contains a large number of very thin and minute crystals, to which the silvery lustre of the skin is owing, and which often exhibit very beautifully the colours of thin plates.

The signification of the various parts of structure of the scales has not been satisfactorily determined; hence we must confine our remarks to simply pointing out the structural peculiarities.

Most scales consist of two portions,—an under, composed of numerous layers made up of very fine fibres taking various directions, and best seen by scraping away the upper portion of the scale after maceration in dilute acid (Pl. 22. fig. 11 *a*). The upper portion consists of concentric plates, the margins of which give rise to the concentric lines so frequently seen in the scales (Pl. 22. figs. 6, 10, 22, 23, &c.). These lines correspond to the margins of the layers, and often present a nodular or crenate appearance (fig. 11 *b*); and towards the middle of the scales they are frequently interrupted and irregularly curved (fig. 11 *c*). The substance of the upper portion appears to be structureless.

In a transverse section, the projecting margins of the laminæ belonging to the upper portion of the scale are seen as so many teeth (Pl. 22. fig. 12.)

Many scales also exhibit radiating lines (Pl. 22. fig. 23), corresponding to furrows in the upper portion of the scales; these are sometimes closed above, so as to form tubes, and have been regarded as nutritive canals.

Near the centre of some scales, as those of the perch, are numerous rounded corpuscles or solid bodies, imbedded in the substance of the upper portion of the scales (Pl. 22. figs. 6 *a* & 7). At the posterior portion of the same scales are often seen

spine-like processes (figs. 6 *b* & 9), with rounded or angular bodies, resembling the last in appearance, arranged in rows at their bases (fig. 8).

The scales of the eel appear to be principally composed of similar bodies, differing only in form, and arranged in concentric rows (Pl. 22. figs. 20 & 20 *a*). They are solid, impregnated throughout with calcareous matter, which is left after incinerating the scales, retaining the original form of the bodies (fig. 21).

In the scales of some fishes, particularly those of extinct genera and species, lacunæ and canaliculi resembling those of bone (Pl. 22. fig. 1 *c*), with Haversian canals, are met with. A vitreous or enamel-like layer, having the structure of dentine, is also met with in the form of an external coating.

The structure of the spines or spine-like scales of the skate is curious. The larger of them consist of a button-like base, surmounted by a sharp process (Pl. 22. fig. 3). The outer and lower part of the base is opaque-white, and consists of an imperfectly fibrous tissue with large areolæ (fig. 37). The spine is hollow, the cavity being continuous with that of a rounded body, partly immersed in the white substance (Pl. 22. fig. 3 *a*). The cavity is filled with a pulp, consisting of lax areolar tissue with minute cells; whilst its walls are composed of a hard substance traversed by branched canals resembling those of dentine (fig. 4). The substance of the smaller spines (fig. 2) exhibits the same dentinous structure (fig. 5).

Pl. 22. fig. 10 represents one of a longitudinal row of scales extending along the middle of the side of the body of most fishes, and traversed by a tube (*a*), formerly supposed to give exit to the mucous secretion of the surface, which view has lately been thrown into doubt. The tubes are visible to the naked eye, and produce the lateral line, as it is called.

The scales of fishes contain a large amount of inorganic matter, composed principally of phosphate of lime, but mixed with the carbonate. The organic basis consists of a cartilaginous substance.

Some years since, Agassiz founded a classification of fishes upon the structure of the scales, having found that with differences in the scales other great and important distinctions were in harmony. The system has been found of eminent service to the geologist; although later researches have shown that scales presenting the characteristics of those belonging to fishes of different orders in this system have been found upon the same fish.

The arrangement was as follows:—

Scales enamelled.

Ord. 1. Ganoid fishes. Those the skin of which is regularly covered with angular thick scales, composed internally of bone, and externally of enamel. Most of the species are fossil, the sturgeon and bony pike being recent.

Ord. 2. Placoid fishes. Skin covered irregularly with large or small plates or points of enamel. Includes all the cartilaginous fishes of Cuvier, except the sturgeon; as examples may be mentioned the sharks and rays. Many are fossil.

Scales not enamelled.

Ord. 3. Ctenoid fishes. Scales horny or bony, serrated or spinous at the posterior margin. Contains the perch and many other existing species, but few fossil.

Ord. 4. Cycloid fishes. Scales smooth, horny or bony, entire at the posterior margin; as the salmon, herring, roach, and most of our edible and freshwater fishes.

Most of the fossil fishes belong to the first two orders, and most of the recent to the third and fourth.

Bibl. Agassiz, *Ann. Sc. Nat.* 2. xiv.; Mandl, *Ann. Sc. Nat.* 2. xi., xii., xiii. & xiv.; Reade, *Ann. N. H.* 1838, ii. 191; Müller, *Wiegm. Archiv*, 1843, 298; Vogt, *Zoolog. Briefe*, ii.; Williamson, *Phil. Tr.* 1849, 435, & 1851; Salbey, *Struct. and Growth of Scales of Fish*, *Ann. N. H.* 1870, v. 67.

SCALES OF INSECTS.—The fine dust which adheres so readily to the fingers on handling a butterfly or moth consists of a number of microscopic flattened bodies, called scales or feathers, upon which the beautiful colours and opacity of the wings depend, the membranous wing itself being transparent and colourless.

These scales have always been favourite microscopic objects, both on account of the beauty and variety of their forms, and the curious markings found upon them. The manner in which they are attached is best examined in the wing of a butterfly. Each has a narrow portion at its base, forming a pedicle or stalk. The stalks are implanted into small and short tubes or cups (Pl. 34. fig. 23 *b*), denominated the squamuliferous tubes, the orifices of which are directed backwards. Around the points of attachment of the cups to the wings, the surface

exhibits a number of irregularly radiating rugæ or folds of the upper membrane of the wing (Pl. 34. fig. 26). The cups are arranged in more or less regular transverse rows. Each scale is composed of two superficial laminæ, enclosing a central lamina of structureless membrane, the surface of which is highly polished.

The scales are variable in form, both in different insects and in different parts of the same insect, being oval, oblong, cordate, obcordate, or cuneate, &c. (Pls. 1 & 34); sometimes they are filiform or capillary (Pl. 34. fig. 27). Their free end is rounded, truncate, toothed, or terminated by a number of hair-like processes; and they are arranged like the tiles of a roof, overlapping each other (fig. 26).

The interesting markings seen upon the scales vary considerably in different insects.

The most common, as seen by transmitted light, are longitudinal, simple, continuous, parallel or slightly radiating dark striæ or lines (Pl. 1. figs. 6, 7, 8, 9 *a*). These are met with upon the scales of nearly all butterflies and many other insects. In some insects the striæ are not simple and continuous, but are made up of rows of smaller striæ in twos or threes meeting at an angle (Pl. 34. figs. 28 *b*, 30 & 31). In others they are composed of a number of bead-like dots, or are interrupted, still preserving their general longitudinal direction (Pl. 34. fig. 24); or they are slightly undulate or irregular, and give off short lateral branches (figs. 23 *a* & 29). In others, again, they present dilatations in certain parts of their course (figs. 20 & 21).

These longitudinal striæ consist of elevations or ridges upon the surface, probably representing folds of the upper layer or membrane of the scale. They often project slightly from the free end of the scale (Pl. 34. figs. 3 & 22); and when moistened, bubbles of air may not unfrequently be found imprisoned between the surface of the scale and the cover, which, being confined between two of the ridges, assume an oblong form. They sometimes contain air, which may be displaced by liquid (Pl. 34. fig. 21). We have never been able to detect tracheæ in these folds or in the scales. A minute conical point or spine sometimes occurs in each of the dilatations when present (fig. 20 *a*).

In the scales of *Podura* (Pl. 1. fig. 12), the striæ consist of longitudinal rows of minute wedge-shaped bodies.

In addition to the longitudinal striæ, on most scales, especially when examined by unilateral oblique light, are seen a number of minute transverse striæ (Pl. 1. figs. 7 & 9 *a*). These are neither indications of ridges nor depressions, but arise from the existence of a number of pigment-granules situated between the two layers of the scale; and the appearance of striæ has the same origin as that in the case of the valves of the Diatomaceæ. This point is best examined in brown or other dark-coloured scales. If perfectly direct light be transmitted through one of these scales, the transverse striæ vanish, their place being occupied by the distinct and isolated granules of pigment (Pl. 1. fig. 9 *b*); the scale should also be immersed in balsam or liquid, to diminish the effects of the refraction arising from the inequalities of the surface of the scale. On then transmitting unilateral oblique light through the scale, the appearance of transverse striæ may be easily produced.

The colours of the scales of insects arise partly from iridescence, partly from the presence of pigment; in general, the brilliant colours depending upon the former, and the more sombre hues upon the latter. The darkness of the longitudinal striæ is caused by refraction; for scales containing no pigment appear perfectly white by reflected light, although the striæ may be very dark.

Upon certain scales, other irregular, more or less transverse curved striæ exist (Pl. 34. figs. 3 & 22); these appear to consist of wrinklings or folds of the under membrane of the scale.

In examining the scales of insects, they should be viewed both in the dry state, and immersed in water, or oil of turpentine; and both by transmitted and reflected light. When the insects are pressed against the slide to remove the scales, a number of globules of oil adhere simultaneously to the slide; and when the cover is applied, the scales often become partially or entirely covered with the oily matter, producing an appearance as if the upper layer of the scale were removed, and rendering the markings so pale and indistinct as to be apparently absent. The appearance of transverse striæ is best produced by turning the mirror to one side, so as to reflect unilateral light.

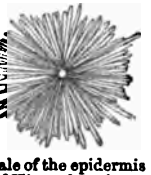
A brief notice of some interesting insects in respect to the structure of their scales is given under the individual heads, as Curculio, Lepisma, Morpho, Podura, Polyommatus, Pontia, Tinea, &c.

See also TEST-OBJECTS.

BIBL. Westwood, *Intr. &c.*, and *Brit. Butterflies*; Deschamps, *Ann. Sc. Nat.* 2. iii. 111; Duj. *Obs. au Micros.*; Ratzeburg, *Die Forst-Insekten*; Siebold, *Vergleich. Anat.*; Pigott and M'Intire, *M. M. J.* 1870, iv. 321; *ib.* 1871, v. 3; Watson, *ib.* ii. 73 & 314; Anthony, *ib.* 1872, vii. 1 & 250; M'Intire, *M. M. Jn.* iii. 1; Maddox, *M. M. J.* v. 33; Woodward, *ib.* v. 149; Beck, *Qu. M. Jn.* 1864, 2; *Mn. Mic. Jn.* iv. 252; Wonfor, *Qu. Mic. Jn.* 1868, 80; Slack, *Mn. Mic. Jn.* vii. 48; Pigott and Beaumont, *Proc. Roy. Soc.* 1873, 222; Wenham, *Mn. Mic. Jn.* 1874, 75; Woodward, *ib.* xv. 253.

SCALES OF PLANTS.—Under the head of HAIRS, mention has been made of scales (*lepides*) occurring on the epidermis of plants. They consist of flat, usually more or less circular plates of cellular tissue, the cells presenting a radiated arrangement from the centre, by which they are ordinarily attached; the margins are usually toothed or fringed more or less regularly by the prolongation of the free ends of the cells. They are closely related to stellate hairs, such as those of ivy, of *Deutzia* (Pl. 28. figs. 26*, 27), &c., and may be regarded as more highly developed forms of these. They are particularly remarkable on the epidermis of certain plants which exhibit a kind of scurfy surface, for example the Eleagnaceæ (fig. 626), the Bromeliaceæ, some Rhododendra, and the lower surface of the leaves of many ferns; they must be distinguished in the last case from the *ramenta* of the stems, which are attached by the base, and not by a central pedicle.

Fig. 626.



Scale of the epidermis of Hippophaë rhamnoides. Magnified 50 diams.

BIBL. See HAIRS and EPIDERMIS.

SCAPHID'IODON, Stein.—A genus of Hypotrichous Infusoria. Free, convex above, flattened and ciliated below, pointed behind; mouth with a cylinder of teeth. *S. navicula*; marine; length 1-240″. (Kent, *Inf.* 750.)

SCARID'IUM, Ehr.—A genus of Rotatoria, of the family Hydatinæa.

Char. Eye single, cervical, rotatory organ armed with a hooked bristle in front; foot forked, very long, adapted for leaping.

Lateral processes of jaws bifurcate, so as to present two teeth each.

S. longicaudum (Pl. 44. fig. 27). Foot as long as or longer than the body, toes shorter than the foot; freshwater, length 1-72″.

BIBL. Ehr. *Infus.* 439; Prit. *Inf.* 686.

SCENEDES'MUS, Meyen.—A genus of Desmidiaceæ.

Char. Cells fusiform or oblong, arranged side by side in a single row of from two to ten, after division forming two alternating rows; division oblique; terminal cells often lunate, or with a bristle at each end.

Several species (Ralfs).

S. quadricauda (Pl. 14. fig. 50). Cells generally four, oblong, rounded at the ends, in a single row, terminal cells with a bristle at each end. Common; length of cells 1-1120″.

S. obliquus (Pl. 14. fig. 51.) Cells elliptico-fusiform, after division arranged in two distinct and generally oblique rows, end cells lunate. Length 1-1670″.

S. obtusus (Pl. 14. figs. 53 & 54, just after division). Cells three to eight, ovate or oblong, all alike, arranged in one row, or after division alternately in two rows. Common; length 1-2330 to 1-1960″.

BIBL. Ralfs, *Brit. Desmid.* p. 189.

SCEPTRONE'IS, Ehr.—A genus of Diatomaceæ. Frustules those of *Synedra*, but the valves cuneiform. Several species, marine and fossil. (Ehrenberg, *Ber. Berl. Ak.* 1844, 264; Grunow, *M. M. Jn.* xviii. 169.)

SCHIS'MA.—A genus of Jungermannieæ (Hepaticæ), founded on a rare British form, *S.* (*Jung.*) *juniperina*, *β. europæa*, found among rocks on the mountains of Scotland, Ireland, and Wales. It grows 3 to 6″ high, and is rarely found in fruit.

BIBL. Hook. *Br. Fl.* ii. pt. 1. 124, *Br. Jung.* pl. 4; Ekart, *Syn. Jung.* pl. 8. fig. 62; Endlicher, *Gen. Plant.* Suppl. 1. No. 472. 17.

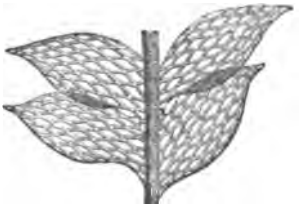
SCHISTOSTE'GEÆ.—A family of operculate Acrocarpous (terminal-fruited) Mosses of gregarious habit. Stem naked below, foliaceous in two manners above; sometimes frond-like or fern-like, composed of leaves attached vertically and connected at the base, with dense areolations consisting of rhomboidal prosenchymatous pellucid or green cells; sometimes with small leaves, like those of other Mosses, horizontal and arranged quincuncially. All the leaves nerveless and flat. Capsule without an annulus, very minute, globular-oval, with a very small convex operculum (figs. 627–630). British genus:

SCHISTOSTEGA. Calyptra cylindrically

bell-shaped. Inflorescence dœcious, plants similar.

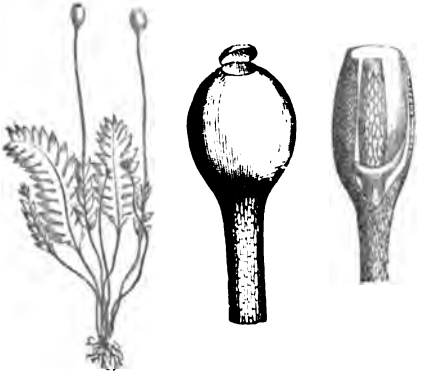
The only species of this genus, the elegant little *Sch. osmundacea*, Web. and Mohr (*Sch. pennata*, Hook. and Taylor), occurs here and there in Great Britain. The name was derived from what appears to have been an erroneous observation of Hedwig, who described radiating fissures in the operculum, which do not exist in living specimens. The germinating confervoid prothallium of this moss was described by Bridel as an alga, under the name of *Catoptridium smaragdinum*; Agardh described it as a *Protococcus* (*smaragdinus*); and it was long supposed to be phosphorescent: this appears to be an error: *Schistostega* grows on the roofs of sandy caves and similar places; and the luminous appearance seems to arise from the condensation and reflection of the little daylight admitted, by the pellucid convex cellules of the prothallium.

Fig. 627.



Schistostega osmundacea.
Leaves of barren branches. Magnified 50 diameters.

Fig. 628. Fig. 629. Fig. 630.



Schistostega osmundacea.

Fig. 628. A plant and fruit. Magnified 10 diameters.

Fig. 629. Open capsule with operculum. Magnified 50 diameters.

Fig. 630. Young capsule opened, showing the columella. Magnified 50 diameters.

SCHIZÆ'A, Smith.—A genus of Schizæaceous Ferns, of curious and elegant structure; several species; exotic (figs. 631, 632).

Fig. 631.

Fig. 632.

Schizæa dichotoma.

Fig. 631. A fertile pinna. Magnified 5 diameters.

Fig. 632. A pinnule with sporanges. Magnified 25 diameters.

SCHIZÆA'CEÆ.—An order of Polypodiaceous Ferns.

Char. Sporangia 2-valved, opening down the side, crowned by a complete operculiform ring; indusium none. Genera:

Schizæa. Sporangia sessile, in 2–4 rows, covering one side of close distichous spikes, which form separate fertile segments at the apex of the fronds.

Anemia. Sporangia small, very numerous, forming a copiously branched panicle, distinct from the leafy part of the frond.

Mohria. Sporangia sessile, on the bark of the leafy frond, near the edge.

Trochopteris. Sporangia small, sessile, placed irregularly round the edge on the under side of the slightly contracted lower lobes of the leafy frond.

Lygodium. Sporangia solitary, or casually in pairs, in the axils of large imbricated clasping involucres, which form spikes, either in separate pinnæ or in lax rows along the edge of the leafy ones.

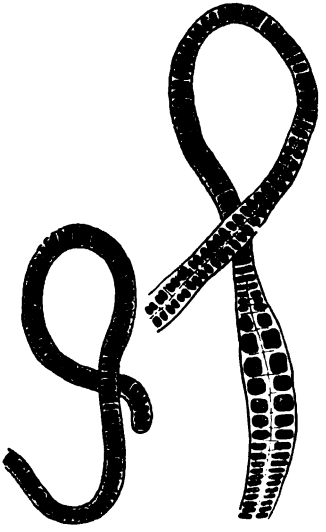
SCHIZOCHLAMYS, Br.—A genus of Palmellaceæ (Confervoid Algæ). *S. gelati-*

nosa (Pl. 3. fig. 16) is found growing upon aquatic plants or floating free, in little gelatinous masses composed of globular green cells, 1-2000″ in diameter, surrounded by a hyaline cell-membrane. The remarkable peculiarity in this genus is the splitting of the hyaline membrane into two or four equal parts by regular, clean dehiscence, the internal cell-mass becoming divided at the same time or remaining unchanged. By frequent repetition of this splitting, the internal cell acquiring a new coat each time, the cell becomes surrounded by a number of fragments of the old coats, held together by a gelatinous matter.

Zoogonidia produced by the division and subdivision of the cell-contents. Macrogonidia and microgonidia exist.

Bibl. Braun, *Verjüngung*, *Ray Soc.* 1853; Kütz. *Sp. Alg.* 891; Rabenh. *Alg.* iii. 32.

Fig. 633.



Schizogonium murale.
Filaments of frond in various stages of development.
Magnified 300 diameters.

SCHIZOGONIUM, Kütz.—A genus of Ulvaceæ (Confervoid Algæ), nearly related to *Prasiola*, distinguished by filiform fronds, which, when young, present only a single row of cells, but subsequently, by collateral subdivision, have two, four, or eight parallel rows. Of the species given by Kützing, the following appear to be British:

S. murale (*Bangia velutina*, Ktz., olim) (fig. 633). Fronds of a single row of cells 1-2400 to 1-2160″ in diam.; double, 1-1440 to 1-1260″; triple, 1-720″; cells half as long as broad, dull green. On damp earth and walls, common.

S. percursum (*Enteromorpha*, Ag.). Frond with a double row of cells, 1-1200 to 1-900″ in diam.; length of cells equal to the breadth; bright or pale green; collapsed when dry. Marine.

S. lætevirens (*Bangia*, Harv.). Frond with a simple row of cells, 1-1800 to 1-1440″ in diam., rigid; with a double row, 1-600″; bright or yellowish green. Marine.

Bangia lacustris, Harv., is given as a doubtful species.

Bibl. Kütz. *Sp. Alg.* 350, *Tab. Phyc.* ii. pls. 98, 99; Harvey, *Brit. Alg.* 1. 172, and *Marine Alg.* 211.

SCHIZOLO'MA, Gaudichaud, = *Lindsaya*, pt.

SCHIZOM'ERIS, Ktz.—A genus of Ulvaceæ (Confervoid Algæ).

Char. Thallus capillary, flattened upwards, fixed by a callous base; growth by cell-division, first in one and then in two directions, so as to form cell-groups of fours. *S. Leibleinii* (Pl. 3. fig. 17); freshwater.

Bibl. Rabenh. *Fl. Eur. Alg.* iii. 311.

SCHIZOMYCE'TES, Näg.—An order of Fungi.

These organisms consist of very minute, mostly colourless cells, or filaments, occurring in organic liquids, or upon organic bodies, from which they derive their nourishment, and the decomposition or putrefaction of which they produce by their vegetative growth. They are sometimes globular, at others cylindrical, more or less distinctly jointed, straight, undulate, or spiral. They were formerly supposed to arise from spontaneous generation; also to be the early forms of Mucedines &c., but their development in this direction has not been traced. Some are motionless, others move by cilia, or internal undulatory motion. In some cases, they secrete a gelatinous material, which unites them into rounded masses, constituting the so-called zooglœa-forms. They are all insoluble in potash or ammonia. They are reproduced by transverse division, or by sporangia and spores; *i. e.* certain of the cells or joints are more persistent, and offer more resistance to outer agencies.

They are stated to cause phosphorescence upon decomposing fish.

The knowledge of these organisms is very

incomplete, and it appears that mere products of decomposition of higher organized bodies, and crystalline precipitates and crystalloids of carbonate of lime have been included among them.

Some are recognized as the zymotic agents in the production of disease, as Typhus and Typhoid Fever, Splenic Fever, &c. Five genera are admitted: *Micrococcus*, cells globular, indefinite; *Sarcina*, cells in cubes; *Bacterium*, cells or joints single or in twos, short; *Spirillum*, fibres undulate, short, inflexible; *Spirillum*, fibres spiral, flexible; *Spirochæte*, fibres helical, long.

See the genera, and the BIBL. of those articles.

SCHIZONE'MA, Ag.—A genus of Diatomaceæ.

Char. Frustules short, straight or sigmoid, resembling those of *Navicula*, aggregated in longitudinal rows in a filiform, simple or branched, slender and lax gelatinous frond. Marine.

Sporangia or sporange-like bodies (spermatia) filled with frustules, occur within the substance of the sheaths. This form of brood-sporangia, as they might be called, appears to resemble that occurring in the Desmidiaceæ (Pl. 10. fig. 3 A).

The species in which the frustules are contained in simple tubes, form the genus *Colletonema*; those in which the tubes are enclosed in outer tubes, the genus *Micromega* (Pl. 17. fig. 8). Rabenhorst includes all in the genus *Schizonema*.

Species very numerous; Smith describes seventeen as British.

S. Dillwynii (Pl. 19. fig. 12). Frond hyaline, tufted, wavy, lubricous, bright green, much branched; end branches short, numerous, patent, attenuate, and somewhat acute; frustules towards the base of the frond remote and scattered, towards the ends crowded, oblong-truncate in front view; valves lanceolate, 1-1020″ in length.

BIBL. Kützing, *Bacill.* 111, *Sp. Alg.* 97; Smith, *Br. Diat.* ii. 71; Rabenhorst, *Alg.* i. 265.

SCHIZONEU'RA, Hartig.—A genus of Aphidæ. 6 species, including *Aphis lanigera*; on the apple, black currant, fir, elm, plum, &c. (Buckton, *Aphid.*, *Ray Soc.* iii. 88.)

SCHIZOPHYL'LUM, Fr.—A genus of Agaricini, characterized by the gills splitting along the edge and becoming revolute.

S. commune is one of the commonest exotic Fungi, and is rare in this country, except introduced accidentally on foreign wood.

BIBL. Fr. *Obs.* i. 103; Sow. t. 183; Grev. t. 61; Berk. *Eng. Fl.* v. 130; Cooke, *Handb.* 16.

SCHIZOPOREL'LA, Hincks, = *Lepralia* pt. Orifice of the cells semicircular or rounded, inferior margin with a notch. Several species. (Hincks, *Polyzoa*, 237.)

SCHIZ'OPUS, Clap. and Lach.—A genus of Hypotrichous Infusoria.

Char. Marginal cirri absent, frontal cirri and uncini present, also dorsal styles. 1 sp. *S. norvegicus*, (Pl. 52. fig. 20); marine. (Claparède et Lachmann, *Inf.* 182.)

SCHIZOSI'PHON, Kt.—Bodies as in *Stichotricha*, but situated in the ends of a branched zoary. *S. socialis*; freshwater. (Kent, *Inf.* 778.)

SCHIZOSI'PHON, Kütz.—A genus of Oscillatoriaceæ (Confervoid Algæ), containing *Calothrix scopulorum*, *fasciculata*, and perhaps other species of Harvey's 'Manual.' Another British species has also been described by Caspary, *S. Warreniæ* (Pl. 8. fig. 13); this extends over large surfaces of maritime rocks, in dull blackish-green tufts of variable size, from 1-4 to 1-2″ in thickness. The erect filaments are fastigiately branched (*a*), the basal cell of the branches broader and hemispherical (*c*); ochreal sheaths obscure (*b*), frequently exhibiting a spiral-fibrous structure in decay (*d*, *e*); apices of the branches much attenuated.

BIBL. Kütz. *Sp. Alg.* 326, *Tab. Phyc.* ii. pl. 47; Harvey, *Mar. Alg.* 224; Caspary, *Ann. N. H.* 2. vi. 266, pl. 8; Rabenhorst, *Alg.* ii. 232.

SCHIZOTHE'CA, Hincks, = *Lepralia* pt. Two species. (Hincks, *Polyzoa*, 283.)

SCHI'ZOTHRIX, Kütz.—A genus of Oscillatoriaceæ (Confervoid Algæ), of which two British species, growing over maritime rocks, have been described.

S. Creswellii (Pl. 8. fig. 17). Tufts 1-2 to 3-4″ high, olive-coloured; filaments curled, 1-3600″ in diameter at the base, 1-12000″ at the summit, in twisted bundles, penicillately corymbose above.

S. Smithii (*Coleonema*), Thw. Stratum dense, dirty red; filaments closely entwined, more or less laterally concreted, 1-9600 to 1-8400″ in diameter; sheaths lax, multiplicate, the internal prolonged and exserted.

BIBL. Kütz. *Sp. Alg.* 320, *Tab. Phyc.* ii. pl. 40; Harvey, *Mar. Alg.* 223, pl. 26 B, *Phyc. Brit.* pl. 190.

SCHIZOX'YLON, Pers.—A genus of Placodei (Lichenaceous Lichens). One species; on oaks, rare. (Leighton, *Lich. Flora*, 390.)

SCHULTZE'S FILMS. See SILICA.

SCHULTZE'S TEST.—This was originally proposed by Pettenkofer as a test for bile; but Schultze found that it reacted also with several other substances, and especially the proteine compounds. In this application it is often of use in discriminating one kind of tissue or substance from another. It consists in treating the matter with strong sulphuric acid, and then adding a little syrup. The characteristic reaction is the production of a purplish-red colour. The best method of proceeding is to wash the substance in question, then to moisten it with a drop of syrup, and finally to add the acid.

The tissues and substances affected by it are muscular tissue, both striated and unstriated; nerve-tubes and cells; the corpuscles of blood, pus, and mucus; epithelial and epidermic scales; hairs; feathers; horn; whalebone; and the cellular portions (cell-contents ?) of Fungi and Algæ.

Those in which the reaction is not produced are areolar tissue, elastic tissue, gelatine and chondrine, chitine, silk, cellulose, gum, starch, and vegetable mucus.

BIBL. Schultze, *Liebig's Annalen*, 1849, *Chem. Gaz.* viii. 98.

SCHULZE'S TEST.—This consists of a solution of chloriodide of zinc, and is used as a test for cellulose, which it colours blue.

The original directions given for its preparation are indefinite; they are as follows:—dissolve zinc in muriatic acid, evaporate the solution with excess of zinc until it acquires the consistence of syrup, and dissolve in this enough iodide of potassium to saturate it; iodine is then added, and the solution diluted with water if necessary.

Radlkofer recommends zinc to be dissolved in muriatic acid, the solution to be evaporated at a temperature but little above that of boiling water, when a liquid of about 2·0 sp. gr. is obtained. This is diluted with water until its sp. gr. is 1·8; if its original sp. gr. was 2·0, 12 parts by weight of water must be added to 100 parts of the solution. In 100 parts of this liquid, 6 parts by weight of iodide of potassium are to be dissolved at a gentle heat, and the mixture heated with excess of iodine until the latter is no longer dissolved, and violet fumes become perceptible over the liquid.

This reagent has the consistence of strong sulphuric acid, and is pale yellowish-brown. It must be kept in a well-stoppered bottle.

BIBL. Schulze, *Flora*, 1850, 643; Schacht, *Mikroskop.* 30 & 197; Radlkofer, *Liebig's Annalen*, xciv. 332, *Chem. Gaz.* 1855, xiii. 372.

SCIA'DIUM, Al. Braun.—A genus of Unicellular Algæ. The young plant is attached to foreign bodies, and consists of a cylindrical cell (*a*), in which are produced eight gonidia; the top of the cylinder falling off like a cap, the gonidia emerge and form an umbel of similar cylinders (*b*), the bases of which stick in the primary cell. Each new cell repeats the process, so as to form a compound umbel; but the gonidia of the third generation (*c*) are set free, forming the primary cells of new families.

S. arbuscula (Pl. 5. fig. 3), on freshwater Confervoideæ &c. Rabenhorst unites this genus with *Ophiocytium*.

BIBL. Braun, *Alg. Unicell.* 48; Currey, *Mic. Jn.* vi. 212; Rabenhorst, *Alg.* iii. 66.

SCI'RUS, Herm.,= *Bdella* pt.; including the species with apparently a head and neck. 5 species, found among mosses, on insects, &c. (Murray, *Ec. Ent.* 144).

SCLEREN'CHYMA. See TISSUES, VEGETABLE.

SCLEROCHI'LUS, Sars.—One of the *Cytheridæ*, with smooth, hard, elongate, bean-shaped valves; lower antennæ 5-jointed; upper 6-jointed, with long setæ; eye single. One living British species; common. (Brady, *Linn. Tr.* xxvi. 455.)

SCLERODER'MA, P. — A genus of Trichogastrous Fungi having a firm peridium, which bursts irregularly, containing large granulated spores separated in masses by floccose veins.

Four species have been found in this country, one of which when young is substituted for truffles, though without any of the fine aroma.

BIBL. Fr. *Syst. Myc.* iii. 46; Berk. *Outl.* t. 15. f. 4; Cooke, *Handb.* 374.

SCLEROT'ICA. See EYE (p. 310).

SCLEROTIUM, Tode.—A large collection of fungoid structures were formerly gathered together under this name, among others the preparatory form of the ERGOT fungus. They are now all regarded as consisting of the *mycelia* of fungi in an imperfect state. The *sclerotioid* state exists when the mycelium forms hard tubercular masses. Analogous masses of mycelial structures occur, in a pulpy condition, in the Vinegar-plant; in a filamentous condition, in those fungi forming large masses of barren *byssus*, &c.; in other cases, as in some of the Myxogastres, the structure is membranous.

BIBL. Léveillé, *Ann. Sc. N.* 2. xx. 218; Berkeley, *Hort. Jn.* iii. 97; Fries, *Sum. Veg.* 477.

SCOLIOPLEU'RA, Grunow.—A genus of Diatomaceæ. Frustules those of *Navicula* or *Pinnularia*, with the median line and hoop curved.

BIBL. Grunow, *Wien. Verh.* 1860; Rabenh. *Alg.* i. 228.

SCOLOPEN'DRIUM, Smith, *Hart's-tongue.*—A genus of Scolopendrieæ (Polypodiaceous Ferns), represented by the indigenous species *Sc. vulgare* (fig. 221, p. 319).

SCOLOPENDRIEÆ. — A family of Polypodiaceous Ferns; containing the single genus *Scolopendrium.*

SCRUPA'RIA, Hincks.—A genus of Eucratiidæ (Polyzoa). *S. clavata*, on other Polyzoa. (Hincks, *Polyz.* 21.)

SCRUPOCELLA'RIA, Van Beneden (*Cellularia*, Johnst., pt.).—A genus of Cheilostomatous Polyzoa, of the family Cellulariidæ.

Char. Cells with a vibraculum behind, and a sessile avicularium at the upper and outer angle; orifice spinous. Five species.

S. scruposa. Cells without an operculum. Common on Algæ, &c.

S. scrupea. Cells with a stalked reniform operculum.

BIBL. Johnston, *Br. Zooph.* 336; Busk, *Ann. N. H.* 1851, vii. 83; Hincks, *Polyz.* 43.

SCUTELLID'IUM, Claus.—A genus of Copepoda. 2 species, on *Laminaria.* (Brady, *Copep.* ii. 175.)

SCUTOVER'TEX, Mich.—A genus of Oribatidæ (Acarina), allied to *Eremæus. S. sculptus*, brown-black. (Michael, *Jn. Mic. Soc.* 1879, ii. 241; 1880, 177.)

SCU'TULA, Tulasne.—A genus of Coccocarpeæ (Gymnocarpous Lichens), parasitic, found upon *Peltigera canina.*

BIBL. Tulasne, *Ann. Sc. Nat.* 3. xvii. 118; Lindsay, *Qu. Mic. Jn.* 1869, 140.

SCYPHID'IA, Duj.—A genus of Peritrichous Infusoria, family Vorticellina.

Char. Body oblong or campanulate, narrowed at the base, which is very contractile, covered with a reticular integument.

S. rugosa (Pl. 31. fig. 74). Body with oblique striæ or rugæ, not numerous; freshwater; length 1-550″. Four other species.

BIBL. Clap. & Lach. *Inf.* 116; Kent, *Inf.* 658.

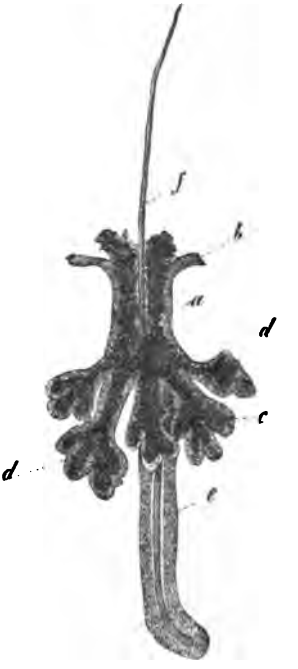
SCYP'HIUS, Koch.—A genus of Trombidina (Acarina). *S. diversicolor*, very minute, in damp moss, under decaying leaves, &c.

SCYTO'MONAS, Stein.—A genus of Flagellate Infusoria. Free, ovate, form persistent, flagellum single, no mouth. *S. pusilla*; freshwater; length 1-1600″. (Kent, *Inf.* 241.)

SCYTONE'MA, Berk.—A genus of Oscillatoriaceæ (Confervoid Algæ), especially distinguished by the mode of branching of the filaments. We can only make out with certainty one British species of the genus as now restricted, *S. Myochrous* (Pl. 8. fig. 19), which grows in alpine bogs and rivulets, and is composed of decumbent filaments interwoven into a dark-brown stratum.

BIBL. Harvey, *Br. Alg.* 1. 155; Hassall, *Alg.* 235, pl. 68; Kütz. *Sp. Alg.* 303, *Tab. Phyc.*

Fig. 634.



Compound sebaceous gland, from the nose, opening upon the surface with a hair-follicle. *a*, *b*, *c*, as in the next figure; *d*, lobules of the compound gland; *e*, hair-follicle (root-sheath); *f*, the hair.

Magnified 50 diameters.

SEBACEOUS FOLLICLES OR GLANDS. — These organs exist pretty

generally in the skin, and secrete a fatty matter. They are mostly seated close to the hair-follicles, into which their ducts usually open. They vary in form, some being simple pouches or depressions of the skin, whilst in others the deeper part of the pouch is branched, so as to constitute a true racemose gland. The narrower portion, or duct, is variable in diameter; it usually opens into the hair-follicle, rather above its middle, but sometimes upon the surface of the skin itself.

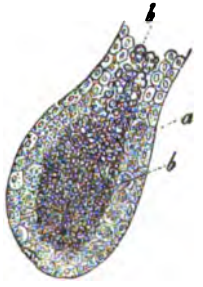
Each gland consists of an outer coat of connective tissue, forming a more or less thick membrane in proportion to the size of

Fig. 635.

Simple sebaceous follicle, from the nose. *a*, glandular epithelium, continuous with *b*, the rete mucosum; *c*, contents of the gland, consisting of cells containing fat, with free fatty matter.

Magnified 50 diameters.

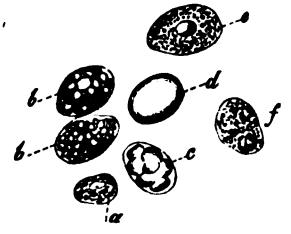
Fig. 636.



Glandular vesicle of a sebaceous gland. *a*, epithelium continuous with the glandular cells *b*, containing fat.

Magnified 250 diameters.

Fig. 637.



Cells rom the glandular vesicles and the sebaceous secretion. *a*, small nucleated cell, containing but little fat, and resembling an epithelial cell; *b*, cells abounding in fat, without evident nuclei; *c*, cell in which the fat-globules are becoming confluent; *d*, cell containing a single drop of fat; *e*, *f*, cells from which part of the fat has escaped.

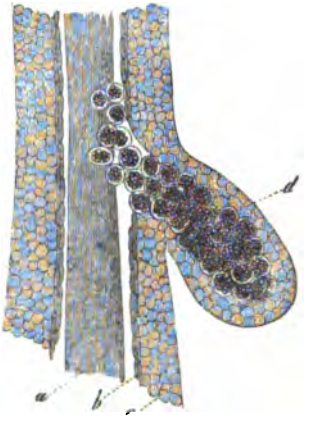
Magnified 350 diameters.

Fig. 638.

Development of the sebaceous follicles in a six-months' fœtus. *a*, hair; *b*, inner root-sheath; *c*, outer root-sheath; *d*, rudimentary follicle.

Magnified 250 diameters.

Fig. 639.



a, *b*, *c*, *d*, as above, but in a more advanced stage.

Magnified 250 diameters.

the gland; this is derived either from the hair-follicle or the cutis, according to the situation of the gland. It is lined by layers of roundish or polygonal, epidermic or epithelial cells, the outermost of which are closely connected, so as to form one or more membranous layers, and contain few or no globules of fat; whilst the inner ones are larger, and almost filled with these globules.

The development of the sebaceous glands commences at the end of the fourth or in the fifth month. The glands at first consist of solid depressions or outgrowths of the rete mucosum of the skin, or the inner root-sheath of the hairs; the inner cells then become filled with fat, loosened, and are finally evacuated through that part of the immature gland which in its subsequent development forms the duct.

Bibl. Kölliker, *Mik. An.* i. 180; Biesiadecki, *Stricker's Hist.*

SECONDARY DEPOSITS OR LAYERS OF VEGETABLE CELLS.—The structures known by this name are spoken of under CELLS, in a general point of view, and in detail under PITTED and SPIRAL STRUCTURES. A few remarks may be given here, connecting the phenomena included under the last two heads.

It is well known that the original or *primary* cell-wall, the layer of cellulose by which the cell first becomes really constituted as a closed membranous sac, is, so far as our present instruments enable us to judge, devoid of detailed structure: it is a homogeneous pellicle. This has a power of extension by interstitial nutrition, which leaves no traces in the perfect membrane, enabling the cell to increase in size. But the increase in solidity is effected by a different process, leaving distinct evidences of its occurrence, namely by an application of successive thin layers of cellulose membrane, more or less completely all over the inside of the primary membrane, giving the cell-wall a laminated character, either evident in the natural condition, or capable of being demonstrated by the aid of maceration or corrosive applications.

No cell which is to form part of a permanent tissue remains long without receiving secondary layers upon its walls. In certain cases the wall exhibits in its natural state merely the laminated structure, without any markings (Pl. 47. fig. 24); but in the majority of cases, where the secondary deposits are considerable, these layers exhibit markings of very peculiar characters. As a general rule, the layers present themselves under two different types, according to the extent to which they cover the primary membrane. In one case they are applied as a general layer over the wall, absent merely at dot-like or slit-like points, where they leave the primary wall uncovered, and thus give rise to a *pitted* condition as seen from the inside of the cell. Successive layers leaving the same spots bare, the pits become gradually deeper, and form canals running through the thick cell-wall to the primary membrane (see PITTED STRUCTURES) (Pl. 47. fig. 23).

Another curious condition of the secondary deposits has been pointed out by Hartig and Mohl, where large patches or spots upon the cell-wall, especially at its base, are left bare by the thicker secondary layers, and become coated with a thin layer perforated by minute orifices, as if riddled with holes, or reticulated; this is called a *sieve-tube* or *clathrate* tissue.

In the other case, the secondary deposits are more sparing in quantity, and are applied over lines forming a definite pattern upon the primary membrane, in which a spiral course in the direction of the long axis of the cell is more or less evident; infinite modifications of this type occur, which are treated of under the head of SPIRAL STRUCTURES (Pl. 48. figs. 7, 9).

In certain less common cases we find the earlier secondary layers exhibiting the pitted character, while others later-formed produce spiral-fibrous thickening, as in *Taxus*, the lime, and other cases (see PITTED STRUCTURES, Pl. 48. figs. 4, 13, 19 *b*).

The last-mentioned cases point to a relation between the spiral-fibrous and the pitted layers, which appears really to exist, for in a great number of cases it is possible to distinguish a spiral structure in the membranous layers of pitted cells, or even of cells where the layers of thickening merely exhibit the laminated structure without any pits or fibrous markings. Thus, in the liber-cells of the Apocynaceæ (Pl. 48. fig. 30), the thickened walls appear under a low power homogeneous, while under higher magnifying-power, and especially by the help of acids, we may detect an evident though delicate spiral structure. The action of acids reveals a similar spiral arrangement of the constituent molecules, in the cotton hair (Pl. 28. fig. 1), and in most liber-cells (figs. 2, 5, 25), in many wood-cells, as of

Pinus, &c. The membranes forming the sheaths of many of the Oscillatoriaceæ (Pl. 8. figs. 13 *d*, *e*, 15) exhibit a spiral-fibrous structure when undergoing dissolution; and an analogous condition may be detected by the help of reagents pretty generally in the cell-walls of the tubular Confervæ. All these phenomena seem to indicate a fundamental identity in secondary layers of all kinds, to which we direct attention under SPIRAL STRUCTURES; but it is convenient to keep the PITTED and SPIRAL-fibrous structures distinct.

The mode of formation of the secondary deposits is not clearly known: some imagine them to be precipitated from the cell-sap upon the walls; others, and apparently with more reason, believe that they are attributable to the agency of the PRIMORDIAL UTRICLE, continuing its action after the formation of the primary membrane. Crüger goes so far as to consider the spiral markings, &c. as dependent on the ROTATION-currents of the protoplasm. There can be little doubt of the mistaken character of Trécul's view, which regards the spiral and other fibrous thickenings as folds of the primary wall thrown inwards.

The secondary deposits appear to be always composed of some modification of cellulose. Mohl has investigated this point very thoroughly; and we have followed him over much of the ground. The cellulose, however, loses its distinctive character with age, either by infiltration with foreign matters, or by a slight chemical metamorphosis, so that old secondary layers do not readily become blue when sulphuric acid and iodine are applied; but as a general rule the cellulose reaction may be obtained by using a preliminary treatment. All internal structures, such as wood-cells, liber-cells, stones of fruits, &c., should be boiled in nitric acid, washed, dried, and tincture of iodine applied; then, if again dried and wetted with water, they turn blue. External structures, such as epidermal cells, cork, and the like, require boiling with solution of potash.

Secondary deposits present considerable difference in their consistence and degree of development in different cases. In most wood- and liber-cells they are abundant in quantity, in some cases almost filling up the cavity (Pl. 47. fig. 27); here they are hard, and appear to be in that state of the cellulose-compound which may be distinguished as *lignine*. The same condition prevails in the stones of fruits, bony shells, the gritty tissue of pears, &c.; and the less abundant secondary substance of spiral-fibrous tissues appears to be in the same state. The secondary layers of parenchymatous cells are usually rather soft and elastic, and often turn blue with sulphuric acid and iodine alone; those of the collenchymatous tissue beneath the epidermis of many herbaceous plants, such as the Chenopodiaceæ, &c., are abundant in quantity, but of somewhat cartilaginous texture. Those of the larger Algæ, and of the thallus of the larger Lichens, approach to the same condition, while the fleshy and horny ALBUMEN of many seeds contains abundant deposits of analogous character (Pl. 47. figs. 21–23); in the latter the composition is sometimes of *amyloid*, approaching starch, stained blue by iodine alone, and more or less soluble in dilute sulphuric acid. The secondary layer of epidermis and corky layers differs again, being usually more sparing in quantity, but very firm and elastic, and strongly resisting decomposing agents; the composition appears to be of that modification of cellulose called *suberine*.

BIBL. Mohl, *Vegetable Cell*, 1852, *Bot. Zeit.* 1847, 97, *Taylor's Scientific Memoirs*, 2. i. 95; Schacht, *Pflanzenzelle*, 1852; Crüger, *Bot. Zeit.* xiii. 1855, 601; Trécul, *Ann. Sc. Nat.* 4. ii. 273; Wigand, *Intercellular-substanz*, 1850; Mulder, *Phys. Chem.*; Henfrey-Masters, *Bot.*

SECRETING ORGANS OF PLANTS; RESERVOIRS OR RECEPTACLES for SECRETIONS.—The structures falling under this head have been in part treated of under the heads of GLANDS and LATICIFEROUS TISSUE; but there still remain certain organs of analogous character, which could not be properly included under either of the above. The name of receptacle or reservoir for peculiar secretions is ordinarily applied to groups of cells, of variable, but most frequently elongated prismatic form, containing special secretions, either in their cavities or effused into their intercellular passages, traversing in the form of cords or bundles the parenchymatous or prosenchymatous tissues. They are almost special characteristics of families, and by no means frequent; the Coniferæ, the Cycadaceæ, the Aloineous Liliaceæ, the Polygonaceæ, Compositæ, Umbelliferæ, Amygdaleous Rosaceæ, Leguminosæ, &c. afford striking examples.

In the Coniferæ the turpentine-reservoirs are very remarkable; and to a certain extent

they render it possible to determine the genus by their arrangement. In *Pinus* they consist of bundles of elongated thin-walled cells, running through the wood parallel to the axis of the stem. These thin-wall cells are densely filled with turpentine; in some cases the cells of the medullary rays are likewise filled with turpentine, and, besides these, perpendicular intercellular passages; the latter form of turpentine-canal is chiefly met with in the bark. Turpentine-canals also exist in the leaves of the Coniferæ, the scales of the cones, &c.

The reservoirs of the Aloes are bundles of prismatic cells accompanying the vascular bundles of the leaves and stems. The colouring-matter of the root of rhubarb is contained in cells of imperfect medullary rays. The structure of the balsam-reservoirs of the myrrh tree, &c. has not been thoroughly studied. The resin- and oil-canals of the Umbelliferæ are of great importance; but the former, chiefly occurring in the roots, are imperfectly known. The oil-reservoir of the fruits (*vittæ*) consists of elongated excavations in the cellular tissue, filled with oil. Canals containing odoriferous oils occur in some of the Compositæ. Resin-canals occur also in the common lime.

Gum-canals, consisting of simple or branched intercellular passages with a special coat of small secreting cells, occur in the leaf-stalks of Cycadaceæ, the bark of the *Amygdaleæ*, the stems of the Malvaceæ, Cactaceæ, &c. Structures of similar nature contain the milky juices of certain plants, as the Anacardiaceæ; and these appear to be different from the ordinary LATEX vessels.

BIBL. Meyen, *Secret.-Organe d. Pflanzen*, 1837, 18; Unger, *An. und Phys. der Pflanzen*, 1855, 204; v. Tieghem, *An. Sc. Nat.* 1872, xvi.; Sachs, *Bot.* 79.

SECTIONS. See PREPARATION; and for Schiefferdecker's section-cutter, *Schultze's Arch.* 1876, xii. 91; a modification, Kiddy, *Qu. Mic. Jn.* 1877, xvii. 35; and Lewis, *M. M. Jn.* xvii. 300.

SEEDS.—These are interesting objects for microscopic examination in respect to many different characteristics. Among them may be mentioned first the variety of beautiful markings upon the surface, which render almost all seeds, like the elytra of beetles, interesting opaque objects for observation with a low power. A few striking forms are represented in Plate 39. figs. 14–18; and we give a list of kinds easily to be obtained.

Hypericum.	*Datura.*	*Maurandya.*
Lychnis.	*Nicotiana.*	*Sphenogyna.*
Stellaria.	*Petunia.*	*Hyoscyamus.*
Reseda.	*Sedum.*	*Sempervivum.*
Lepidium.	*Saxifraga.*	*Limnocharis.*
Nigella.	*Capparis.*	*Silene* (Pl. 39.
Erica.	*Elatine.*	figs. 16, 17).
Anagallis.	*Gesnera.*	*Dianthus* (Pl. 39.
Orobanche.	*Begonia.*	fig. 15).
Linaria.	*Delphinium.*	*Papaver* (Pl. 39.
Chironia.	*Scrophularia.*	fig. 14).
Gentiana.	*Antirrhinum.*	*Digitalis* (Pl. 39.
Mesembryanthemum.		fig. 18).

The following are well seen when mounted as transparent objects in Canada balsam.

Parnassia.	*Pyrola.*	*Saxifraga.*
Drosera.	*Monotropa.*	*Rhododendron.*
Orchis.	*Hydrangea.*	

The *testa* or outer skin of some of the latter (also *Begonia*), when removed from the seed and viewed with a high power, exhibits elegant pitted cells. The surface of the seed of *Cobæa* is mealy with little scales consisting of pyriform cells containing a spiral fibre (Pl. 28. fig. 20).

The surface of various seeds, such as *Collomia* and *Ruellia*, and the pericarp of many seed-like fruits, such as that of *Salvia* and *Senecio*, present remarkable HAIRS.

The stones of plums or cherries, the so-called shell of the Cocoa-nut and similar fruits, exhibit remarkably thick SECONDARY DEPOSITS.

The examination of the structure of ripe seeds is a matter of great importance in botany. The investigation will vary much according to circumstances. Where seeds are large, the microscope is only required for the examination of their tissues; but small seeds must be examined by dissection with needles under the simple microscope, or by sections, which are most easily made by fixing the softened seed into a piece of wax. Seeds have two coats, the *testa* and *tegmen*, or external and internal membrane, and, according as the seed is or is not albuminous, an albumen enclosing the embryo, or an embryo of larger size immediately invested by the coats. The characters of the ALBUMEN and EMBRYO will be found under these heads, as also other particulars under OVULE. Embryos are either Monocotyledonous or Dicotyledonous; sometimes, however, the two cotyledons are soldered together more or less completely. In the Coniferæ and certain genera of Dicotyle-

donous Angiosperms, as *Schizopetalum*, the cotyledons appear to be four, six, or more in number; but the observations of Duchartre show that there exist only two—bifid, trifid, or multifid cotyledons. In other cases, as in *Orchis*, the embryo remains imperfectly developed, and appears as a mere cellular mass in the ripe seed before germination; this is destitute of albumen; but in *Orobanche* an amorphous embryo is found imbedded in the albumen.

BIBL. *General works on Botany.*

SEIROS'PORA, Harv.—A genus of Ceramiaceæ (Florideous Algæ), containing one rare species, *S. Griffithsiana*, a little crimson feathery sea-weed, composed of single jointed tubes, the joints being traversed by articulated filaments. The spores are unknown; but the *tetraspores*, which serve to distinguish this plant from the *Callithamnia*, occur in terminal beaded strings, being formed out of the ramuli.

BIBL. Harvey, *Mar. Alg.* 170.

SE'JUS, Koch, = *Gamasus*, pt. (Koch, *Uebers.* 92; Murray, *Ec. Ent.* 164.)

SELAGINEL'LA, De Beauv.—A genus of Lycopodiaceæ, distinguished from *Lycopodium* by the presence of two kinds of spores and the dissimilar habit.

This genus includes only one of our native Club-mosses, *S. spinosus* (*Lyc. selaginoides*); but most of the so-called *Lycopodia*, now so extensively cultivated in Wardian cases, fern-houses, &c., belong to this division (fig. 428, p. 481). The principal particulars relating to these plants, especially the remarkable history of the reproduction by the spores, are given under LYCOPODIACEÆ.

BIBL. See LYCOPODIACEÆ.

SELENITE.—This well-known mineral substance consists of crystallized hydrated sulphate of lime. Its crystals belong to the oblique prismatic system; and the colours exhibited by thin laminæ, into which they may be easily split, are very beautiful under polarized light. Polarizing crystals and organic substances, in which the thickness is not suited to the production of distinct colours under the polariscope, may be made to exhibit them by placing a plate of selenite beneath the object. For this purpose, the plate is usually kept mounted in Canada balsam. See POLARIZATION.

SELIGE'RIA, Br. & Sch.—A genus of Leptotrichaceous Mosses, including certain *Weissiæ* of authors; having the leaves setaceous, and the capsules pyriform.

SENDTNE'RA, Woods.—A genus of Jungermannieæ (Hepaticæ), mostly tropical; one species of which, *S.* (*Jung.*) *Woodsii*, occurs rarely in the mountains of the S.W. of Ireland (devoid of fruit).

BIBL. Hook. *Br. Fl.* ii. pt. 1. 126; *Br. Jung.* pl. 66; Ekart, *Syn. Jung.* pl. 12. f. 108; Endlicher, *Gen. Plant.* Supp. 1. No. 472–16.

SENE'CIO.—The surface of the achænia or seed-like fruits of the common groundsel (*Senecio vulgaris*) is sparingly clothed with HAIRS of a peculiar character. These appear to consist of two semicylindrical cells applied together by their flat faces, so as to form a kind of tube with a vertical septum. When placed in water they expand somewhat, and the contents are expelled from the ends, consisting of an indistinctly spiral-fibrous structure, which untwists and expands by the absorption of water, to twice or three times the length of the hairs, in a manner comparable in some degree to the behaviour of the contents of the hairs of ACANTHACEÆ. (Leighton, *Ann. N. H.* vi. 259.)

SEPEDONI'EI.—A family of Hyphomycetous Fungi, consisting of a heterogeneous assemblage of imperfectly known genera, and differently defined by different authors. Those genera we have included in our list are enumerated in Lindley's 'Vegetable Kingdom;' but Fries includes *Oidium* and others. The general character of the family is, that the plants produce spores lying immediately upon the decumbent filaments of the mycelium, or upon short pedicels. Genera:

Artotrogus. Entophytic; filaments creeping, persistent; spores springing from the middle of the filaments, simple, at length free, spinous.

Sepedonium. Filaments woolly, septate, evanescent; spores globose, connate, scabrous, stalked, solitary, at length heaped together.

Fusisporium. Spores fusiform or cylindrical, glued together in heaps resting on the gelatinous matrix.

Epochnium. Spores heaped, oblong, apiculate, septate, adnate to the matrix, interwoven with the effused, entangled, slender filaments of the mycelium.

Psilonia. Spores simple, pellucid, not glued together, at first covered by the converging filaments of the mycelium.

Monotospora. Epiphytic; filaments creeping, evanescent; spores globose, solitary, terminal, at length free.

Asterophora. Filaments creeping, ramuli branched, the fertile terminating in a spiral

coil, composed of about 3 joints, one of which swells into a rough-coated spore.

Zygodesmus. Filaments creeping, branched, with short ramuli bearing echinate spores, the pedicels with a lateral indentation looking like a joint.

SEPEDO'NIUM, Link.—A genus of Sepedoniei (Hyphomycetous Fungi), containing two species, growing upon decaying Fungi. *S. chrysosperma* has golden-yellow spores, *S. roseum* red ones. The first is common. The species are all forms of Sphæriacei.

Bibl. Berk. *Br. Fl.* ii. pt. 2. 350; Fries, *Sum. Veg.* 497; Grev. *Crypt. Flor.* pl. 198.

SEPIA, Linn.—A genus of Cephalopoda. The structure of the dorsal internal shell of *S. officinalis*, the cuttle-fish, called the cuttle-bone or sepiostaire, presents a curious structure. It is oval, flat, convex, horny outside, the interior being calcareous and composed of numerous friable, horizontal, parallel, calcareous plates, separated by innumerable minute perpendicular flattened columns, with transverse thickenings at pretty regular intervals, producing a striated appearance. When mounted in balsam, it forms an interesting polarizing object.

SEPTONE'MA, Corda.—A genus of Torulacei (Coniomycetous Fungi), related to *Torula*, and connecting this in some measure with *Dendryphium*. *S. spiloma*, forming green tufts on old rails, has been found in Guernsey. Several species are recorded as French by Léveillé, one forming patches on vine-leaves, the others on the potato. The chains of septate spores soon break up.

Fig. 640.

Septonema viride. Magnified 150 diameters.

Bibl. Corda, *Ic.* i. & ii.; Fries, *Sum. Veg.* 504; Léveillé, *Ann. Sc. Nat.* 3. ix. 261; Berkeley and Broome, *Ann. N. H.* 2. v. 461; Berk. *Lond. J. Bot.* iv. t. 12. fig. 5.

SEPTO'RIA, Fr.—A genus of Sphæronemei (Coniomycetous Fungi), but probably in reality consisting of preparatory forms of *Sphæriæ*. They grow upon the leaves of plants, the fusiform septate or inarticulate thread-like "spores" oozing out from a pore in the form of a tendril.

S. Ulmi and *S. Oxyacanthæ* are common; numerous other species are recorded.

Bibl. Berk. *Br. Fl.* ii. pt. 2. 356; Berk. and Br. *Ann. N. H.* 2. v. 379, xiii. 460; Tulasne, *Ann. N. H.* 2. viii. 117, 4. v. 115.

SEPTOSPO'RIUM. See Macrosporium.

SERIALA'RIA, Lamarck.—A genus of Vesiculariidæ (Polyzoa). *S. lendigera*, the only British species, is not uncommon on Fuci, near low-water mark. (Hincks, *Polyz.* 515.)

SEROUS MEMBRANES.—These consist of the same elements, arranged in the same number of layers as in the Mucous Membranes. The thickness of the layers, however, is considerably less, the fibrous elements are finer, and the epithelium forms a single layer only of polygonal cells. The communication of the lymphatics with the so-called stomata is noticed at p. 485.

Bibl. That of Tissues, Animal.

SERRA'TOR, Mégnin. See Acarus, p. 5 (Mégnin, *Paras.* 144).

SERTULAREL'LA, Gray.—A genus of Sertulariidæ (Hydroid Zoophytes).

Char. Cells biserial, alternate, with a toothed orifice and an operculum composed of several pieces. *S. rugosa* (formerly *Sertularia r.*, Pl. 41. figs. 11 & 12); common upon *Flustræ*, *Fuci*, &c. at low-water mark. (Hincks, *Br. Hydr.* 234.)

SERTULA'RIA, Linn.—A genus of Hydroid Zoophytes, family Sertulariidæ.

Char. Polypidom plant-like, fixed by its base, variously branched, the branches formed of a single tube, denticulated or serrated with the cells, and jointed; cells alternate, semialternate, or opposite, biserial, sessile, urceolate, with everted apertures; ovarian vesicles scattered.

Many of these elegant zoophytes, which would at once be referred to the vegetable kingdom by any casual observer, are commonly found on the sea-coast, either loose or attached to shells, sea-weeds, &c.

S. pumila (Pl. 41. figs. 13 & 14). Cells opposite, approximate, shortly tubular, the top everted, with an oblique somewhat mucronate aperture; vesicles ovate; common on Fuci near low-water mark.

S. operculata (Pl. 41. figs. 15 & 16). Cells opposite, inversely conical; aperture patulous, obliquely truncate, pointed on the outer edge, and with two small lateral teeth; vesicles obovate.

Bibl. Johnston, *Brit. Zoophytes*, 61; Hincks, *Hydr. Zooph.* 259.

SERTULARI'IDÆ.—A family of Hydroid Zoophytes.

Char. Capsules quite sessile on a horny polypidom; egg-germs contained in scattered deciduous capsules. British genera:

Halecium. Polypidom plant-like; stem consisting of several parallel tubes; cells shallow cups, on opposite sides, alternate, one under each joint.

Sertularia. Plant-like; stem simply tubular, branched, jointed; cells vase-like, alternate or in pairs, on opposite sides, with everted rims.

Reticularia. Polypidom an investing network of horny tubes, immersed in a homogeneous horny crust; cells short curved projections of the tubes, with simple round orifices.

Coppinia. Parasitic, massive, hairy; cells long, tubular, often curved, arising at irregular distances (generally at the angles of junction) out of a cellular basis, the apertures of the cells or spores of which are often themselves covered in by a lid perforated by a small tubular orifice.

Thuiaria. As *Sertularia*, but the cells closely pressed to or imbedded in the surface of the stem and branches.

Antennularia. Simple or branched, jointed, with slender hair-like whorled branchlets; cells small cups on the inner side of the branchlets; egg-vesicles seated in the angles.

Plumularia. Simple or branched, feathery; cells small, usually in the angles formed by horny spines on the inner side of the branches; egg-vesicles scattered.

Bibl. Hincks, *Hydr. Zooph.* 233.

SETOSEL'LA, Hks.—A genus of Polyzoa=*Membranipora* pt. *S. vulnerata*, on very small stones in deep water. (Hincks, *Polyz.* 181.)

SHEEP-TICK. See Melophila.

A species of *Trichodectes* (*sphærocephalus*) is also found as a louse upon sheep.

SHELL of Animals.—In this article we shall notice the various substances comprised under the term shell, in its common acceptation. See Pl. 45. figs. 1–16.

Egg-shell.—As an example of the structure of the egg-shell of birds, we may select the shell of the egg of the common fowl.

This is lined internally by a loosely adherent layer of a thin yet firm albuminous membrane, called the membrana putaminis. It consists of a number of very slender fibres, interlacing in various directions. In imperfectly formed or soft eggs, as they are called, the fibres present thickenings at irregular intervals, resembling, on the whole, the nuclear fibres of elastic tissue with the remains of their formative cells still visible. On macerating the shell in dilute muriatic acid, an outer layer of this membrane, inseparably adherent in the natural state to the inner surface of the shell, may be detached.

The membrane may be heated to boiling in solution of potash without undergoing solution, and is insoluble in acetic acid; but it is coloured by Schultze's test.

The substance of the shell consists of numerous masses of secretion, or protoplasts, impregnated with calcareous matter. In soft eggs, these form rounded, loosely adherent masses (Pl. 45. fig. 12), may easily be detached from the surface of the egg, and contain but little calcareous matter; whilst in the perfect egg they are somewhat angular from mutual pressure, and abound in calcareous granules having an imperfectly radiating arrangement (Pl. 45. fig. 13); this is most easily perceived in the inner portions of the shell.

The structure of the shell of the ostrich presents a curious variety. In a section parallel to the surface (Pl. 45. fig. 14) the protoplast structure is visible, but the calcareous matter is arranged in the form of triangular plates, often fused together, and leaving angular interspaces. The perpendicular section is represented in Pl. 45. fig. 15. The former section constitutes an interesting polarizing object.

Tortoise-shell.—This substance is an epidermic formation, structurally resembling horn, in so far as it consists of epidermic cells flattened and united into numerous superimposed plates. The long-continued action of solution of potash (from twenty-four to forty-eight hours), and the subsequent addition of water, are necessary to resolve tortoise-shell into its component cells.

Shells of the Mollusca.—The structure of these shells varies in the different orders, &c. of the class; and a knowledge of the respective varieties has been used as an aid to the recognition of fossils, and the determination of the affinities of the genera, families, &c.

In the bivalve Mollusca, two kinds of structure may be distinguished, an outer prismatic or fibrous, and an inner laminated.

The outer prismatic portion consists of flattened masses or plates of crowded polygonal prisms, placed sometimes perpendicularly, sometimes obliquely to the surface

of the inner layer. These prisms are transparent, and polarize light, possessing a crystalline structure, although their forms are not crystalline but those resulting from mutual pressure. Transverse sections of the prismatic structure exhibit a cellular appearance (Pl. 45. figs. 4 & 11 *a*); and a somewhat similar appearance is presented by perpendicular sections (figs. 5 and 11 *b*). The prisms are pretty easily separable in the lines of mutual contact, and often form several superimposed strata. They frequently contain pigment, either uniformly diffused through their substance, or in granules. They also sometimes appear transversely striated.

The inner laminated portion, which sometimes constitutes the entire shell, is either white or presents the brilliant iridescent tints of nacre or mother-of-pearl. It is often called the nacreous portion, or nacre, and when polished forms the mother-of-pearl of the shops. Under the microscope it exhibits a number of fine lines or grooves, running in various directions, and probably corresponding to the edges or intersections of the strata or laminæ of which this portion of the shell is composed; and it is to the interference of light ensuing at the surfaces of these grooves that the iridescent colours are usually owing.

In some shells (*Terebratulæ*) there are tubes traversing the substance perpendicularly (Pl. 45. fig. 7) or obliquely, or forming branched horizontal channels (fig. 9 *a*, *b*); in the latter case they are sometimes connected with rounded cavities (fig. 9 *a*).

In some Gasteropoda, as *Cypræa*, the outer portion of the shell consists of three layers of similar prismatic structure, but with the prisms in each layer in alternately contrary directions. The same may be seen in some of the outer layers of oyster-shell, except that the prisms are nearly horizontal or slightly oblique. But in the Acephala generally, the structure corresponds to the inner portion of that of the Cephalophora.

Shell consists of an organic basis, in which calcareous matter, principally composed of carbonate of lime, is deposited; and by digesting it with dilute muriatic acid, the latter may be removed, an organic cast of the original being left. On treating a thin plate of nacre in this way, Carpenter found that the iridescent colours remained visible until the membrane was stretched and the supposed folds obliterated, when they vanished; hence this author concludes that the edges of the folds were the cause of the interference of light producing the colours. It appears to us, however, objectionable to this view, that the same structure and colour are produced by laminated calcareous and organic matter artificially formed; that they are also present after the edges of the folds must have been ground away, as in sections; and that the colours, in the instance mentioned, might have been those of a thin plate, and some of the colours of iridescent shell are known to be those of thin plates. It may be stated here that Carpenter considers the lines or striæ in nacre to be produced by the edges of folds of a single layer of membrane, arranged so as to lie over each other in an imbricated manner. The same author views the shell of the Mollusca as corresponding to the epidermis of the higher animals, calcified.

The outer prismatic layers of shell are secreted by the borders or margins of the mantle, whilst the inner laminated portions arise from the outer surface. The growth of shell is not uninterrupted or constant, but periodical; hence the laminated arrangement of its constituents.

In some portions of the shell of the oyster, &c., the calcareous matter assumes the form of distinct rhomboidal or hexagonal crystals (Pl. 45. fig. 10). These appear to be deposited in the inner laminated portion; and when detached they leave angular spaces corresponding to them in form. In the tooth of the shell of *Mya*, groups of radiating prisms are present, forming an elegant microscopic object.

The prisms existing in the outer portion of shells have been supposed to represent cells filled with calcareous matter; they have also been regarded as consisting of aggregations of epidermic cells, the transverse striæ (in *Pinna*) corresponding to thickenings of the cell-membranes where the layers come into contact; and the folded membrane has been compared to a basement membrane. It is probable, however, that shell should be regarded as a simple secretion from the mantle, and as corresponding in structure to egg-shell.

Shell of the Crustacea.—The hard portion of the integument of the Crustacea, alluded to at p. 215, possesses a laminated structure, corresponding to periods of growth, and giving rise to the appearance of transverse parallel lines in a perpendicular section (Pl. 45. fig. 16). The substance is traversed by numerous straight, or slightly wavy,

very slender tubes (Pl. 45. fig. 16), resembling those of dentine.

Shell of Echinodermata.—The perforated structure of the homogeneous basis forming this substance has been already noticed (p. 274). In the spines of *Echinus, Cidaris,* &c., the calcareous network consists of slender fibres with large areolæ at intervals, arranged in a somewhat regular pattern, and traversing a solid homogeneous substance, which is thus divided into a number of ribs or pillars. The transverse section of these is seen in Pl. 45. figs. 6 & 6 *a*.

Carpenter regards the calcareous network as corresponding to the fibrous structure of the cutis of the higher animals, calcified. This view does not, however, account for the intervening substance.

The method of procuring sections of shell is noticed under PREPARATION.

BIBL. Carpenter, *Tr. Brit. Association,* 1844 & 1847; *Ann. N. H.* 1843, xii. 376; Gray, *Phil. Tr.* 1833; Deshayes, *Todd's Cycl. An. &c.* iv. 556; Bowerbank, *Tr. Micr. Soc.* 1844, i.; Lavalle, *Ann. Sc. Nat.* 3. vii.; Siebold, *Vergl. An.*; Brewster, *Phil. Tr.* 1814, and *Optics,* 1853; Woodward, *Shells*; Williamson, *Qu. Mic. Jn.* viii. 35; Carpenter, *The Microscope,* 1881, 666.

SIAGONTHE'RIUM, Perty.—A genus of Enchelia. Body ovate, very minute, colourless, with an antero-lateral tuft of reflexed cilia. *S. tenue,* in bog-water. (Perty, *Inf.* 150.)

SI'DA, Baird (*Daphnia,* auct.).—A genus of Entomostraca, of the order Cladocera, and family Daphniidæ.

Char. Anterior branch of inferior antennæ two-jointed, posterior three-jointed and with a row of spines at its anterior margin; legs six pairs.

S. crystallina (Pl. 19. fig. 27). The only species; freshwater.

Daphnella belongs here.

BIBL. Baird, *Brit. Entom.* 107.

SIDEROLI'NA, Lamk.—Another name for CALCARINA. (Carpenter, *For.* 199, 223.)

SIDY'NUM, Sav.—A genus of Tunicate Mollusca, of the family BOTRYLLIDÆ.

S. turbinatum. Amber or orange. On the underside of shelving rocks. (Forbes and Hanley, *Br. Moll.* i. 13.)

SIEVE-TUBES.—These are thin-walled, elongated cells, united end-to-end in rows, the intervening transverse portions, or bases of the cells, forming perforated sieve-like plates; the sides next other sieve-tubes are also sometimes perforated. The protoplasm of the cells passes through these perforations, forming minute fibres.

Sieve-tubes are found in the liber of Dicotyledons, and in the fibro-vascular bundles of Endogens. They may be most easily obtained from the stems or leaf-stalks of *Cucurbita pepo, Calamus Rotang, Potamogeton natans, Bignonia speciosa, Vitis vinifera,* &c. Sachs recommends that their longitudinal sections be treated with solution of iodine until the cell-contents are rendered brown, and the subsequent addition of sulphuric acid; this dissolves the cell-wall and sieve-plates, allowing the slender protoplasmic filaments to be distinctly seen.

BIBL. Sachs, *Bot.* 89; Henfrey-Masters, *Bot.* 487; Wilhelm, *Bot. Centralblatt,* i. 908, *Jn. Micr. Soc.* 1881, i. 72.

SILICA.—This inorganic substance is most abundantly met with in the mineral kingdom, in the form of earth, sand, or distinct crystals. The crystals belong to the rhombohedral system, usually forming six-sided prisms, terminated by six-sided pyramids. The mineral forms are noticed under AGATE, including chalcedony, and under ROCKS.

In the animal kingdom, it is met with especially in the Protozoa, forming the spicula and elegant siliceous shells so well-known as microscopic objects, and which are noticed under the heads of the classes, genera, &c.

In the vegetable kingdom, silica is a constant constituent of the epidermis of the Graminaceæ, the Equisetaceæ, and certain Algæ, especially the valves of the Diatomaceæ.

Chemically it is distinguished by its insolubility in boiling nitric acid, and its indestructibility by a red heat.

If, as Schultze first pointed out, some sulphuric acid be added to a mixture of powdered fluor-spar and sand, in a wide-mouthed flask, with a short tube of moistened blotting-paper in the neck, the fluoride of silicium, which is evolved, is decomposed, and silica is deposited in films upon the paper. If these are washed in distilled water, dried, and examined under the microscope, they are found to consist of minute crystalloid hemispheres of silica, often pointed, and grouped into plates. The finer ones present considerable resemblance to the markings of the finer valves of the Diatomaceæ, when so minute as to be only visible by their lenticular foci or their dif-

fraction-spectra, whence they were considered to represent and explain the formation of the siliceous structure of the valves, and have been called Schultze's films. The coarser ones have no resemblance whatever to the coarser markings of the Diatomaceæ. Their relation to the valves of the Diatomaceæ has been referred to under DIATOMACEÆ.

Silica has but little action upon polarized light; in fact, Schultze states that the apparent depolarization is due to refraction. The selenite-plate will, however, render it more evident in many instances in which it is feeble.

BIBL. Works on Chemistry; and Schultze, *Verh. Naturh. Vereins. preuss. Rheinlande*, XX. 1, *Qu. Mic. Jn.* 1863, iii.

SILK.—This valuable substance is secreted in Insects, especially the silkworm, by two glandular organs, described under INSECTS, *Spinning Organs*.

The fibres of which it is composed are cylindrical or somewhat flattened, solid, tolerably highly refractive, and free from structural markings of any kind.

Chemically, silk consists of a proper silk-cylinder, consisting of fibroine and forming the principal part of the fibres, surrounded by a coat of albumen, upon which is a layer of gelatine. The fibres also contain a small quantity of fat and colouring-matter.

Fibres of silk may easily be distinguished from those of linen or cotton by the application of Millon's or Schultze's test, both of which colour the silk, but neither of them the linen or cotton. The test for cellulose is equally applicable to the same purpose.

SIMULTANEOUS BUNDLES. See VASCULAR TISSUE.

SIPHOCORY'NE, Buckt.—A genus of Aphidæ. (Buckton, *Aphid.* ii.)

SIPHONA'CEÆ.—A family of Confervoid Algæ, either marine, freshwater, or growing on damp ground; characterized by the individual fronds being composed of large branched cells, the contents of which expelled in various forms serve for the reproduction. The fronds mostly have a more or less compound character, either from regular ramification, or by a kind of stoloniferous multiplication at the base of the cells; and in *Hydrodictyon*, which seems best placed in this family, the cells are always connected together by their extremities, so as to form a net-like frond. In the majority of the genera the cell-contents are green. The modes of reproduction exhibit considerable diversity, and are probably still imperfectly known in most of the genera. *Codium* and *Bryopsis* are reproduced by the discharge of the contents of certain cells in the form of numerous small ciliated zoospores. *Vaucheria* is increased by large elliptical solitary zoospores, covered with vibratile cilia; in *Hydrodictyon* the cell-contents are converted into a multitude of ciliated zoospores, which unite to form a new net or frond before leaving the parent cell; while in *Botrydium* the cell-contents are said to he discharged in the condition of motionless gonidia; but we imagine this point is not quite certain. In addition to the gonidial reproduction, spores have been discovered in *Vaucheria*, and will probably be found in the rest. In *Vaucheria* they occur in special branch-cells; here, however, accompanied by antheridial cells, which produce spermatozoids, fertilizing the sporangial cell. Spores have not yet been observed in the other genera; but it is to be expected that they will be found in them also. More particular details on the very interesting genera of this somewhat heterogeneous family will be found under their respective heads. *British genera*:

Codium. Filaments green, branched, closely interwoven into a spongiform frond, producing biciliated zoospores in sporangial cells borne on the sides of the erect clavate branches; marine.

Bryopsis. Filaments green, free, pinnately branched, producing two- or four-ciliated zoospores in the extremities of the branches; marine.

Vaucheria. Filaments green, more or less branched, continuous, producing in their apices large solitary zoospores covered with cilia; also bearing lateral globose sporangial cells and hook-like antheridial cells or horns; marine or freshwater, and still more commonly on muddy ground, damp garden-pots, &c.

Botrydium. Frond a spherical green vesicle seated on a ramified filamentous base, the cavity of the whole continuous; the ramified base producing new vesicles, sporanges, by stoloniferous growth. Multiplied by the granular contents of the vesicle discharged by a rupture at the summit. On damp, mostly clayey ground subject to floods.

Hydrodictyon. Frond a green bag-like net, with usually pentagonal open meshes, formed of cylindrical cells connected by their ends. Reproduced by ciliated zoo-

spores formed in the "link"-cells, uniting together and forming a perfect miniature net before escaping from the parent cell.

See also PYTHIUM.

SIPHONI'NA, Reuss.—A low form of *Planorbulina*, having open-mouthed tubes leading off the pseudopods from the chambers, and large-necked septal orifices. Recent and fossil in the Mediterranean area. (Parker and Jones, *Ann. N. H.* 3. xi. 94.)

SIPHONOPH'ORA, Koch.—A genus of Aphidæ. Species numerous, on a variety of plants. *S. rosæ*=*Aphis r.* (Buckton, *Aphidæ*, i. 104.)

SIPHONOPH'ORA.—An Order of Hydro-medusæ; the oceanic Hydrozoa. (Huxley, *Phil. Tr.* 1849.)

SIPHONOS'TOMA (Parasita, or Pœcilopoda).—An Order of Crustacea.

Char. Body often almost entirely enclosed in a buckler, consisting generally of one, sometimes of two pieces; mouth suctorial; legs formed for walking or prehension, or partly branchiferous and fitted for swimming. Parasitic upon fishes, &c.

These animals (Pl. 19. figs. 7, 23, 24, 36, and Pl. 20. fig. 1), which often present the most extraordinary forms, are found mostly affixed to the gills of fishes by means of hooks, arms, or suckers, arising from or consisting of modified foot-jaws. In some, the cephalothorax is distinct from the abdomen, and the head is more or less distinct from the thorax; whilst in others the body presents more of a worm-like form, is occasionally ringed or segmented, and sometimes exhibits simple or branched lateral lobes or processes. The antennæ are mostly rudimentary. Flattened elytriform dorsal appendages are sometimes present. The rostrum is conical, tubular, and furnished with two setaceous or styliform mandibles. The alimentary canal is straight, without a gastric expansion, and its orifices at the two ends of the body. In some, branchial plates form the respiratory organs; but in most the same office is performed by the skin.

The sexes are distinct, although they are not known in all the species. The males are smaller than the females. The ova are often attached to the lower part of the body of the females, either contained in external ovaries, or simply glued together by the secretion from a special gland, and forming long, cylindrical, straight or convolute appendages. The young animals have but few legs, swim freely, and frequently resemble the young of *Cyclops*.

BIBL. Baird, *Br. Entomostr.*; M.-Edwards, *Hist. Nat. Crust.* iii.; Siebold, *Vergl. An.*

SIROC'ROCIS, Kütz. — Probably the mycelium of a fungus.

BIBL. Kützing, *Sp. Alg.* p. 153.

SIROGO'NIUM, Kützing.—*S. notabile*=*Mesocarpus notabilis*, Hass.; *S. stictícum*=*Spirogyra* (*Zygnema*, Hassall) *stictica*; *S. breviarticulatum*=*Spirogyra curvata.*

SIROSI'PHON, Kütz.—A genus of Oscillatoriaceæ (Confervoid Algæ), which should perhaps have been placed under the older name of *Hassallia*. This genus is principally distinguished by the solitary branches passing off from the sides of the rather rigid filaments, the branches arising from longitudinal division and lateral growth of interstitial cells. The plants are black, and found on wet moors, rocks, &c. Two species seem to be established—*S. ocellata* (Pl. 8. fig. 12), and *S. compacta*; Leighton places the latter among the Lichens; others appear doubtful.

BIBL. Hassall, *Alg.* 231; Kützing, *Sp. Alg.* 315, and *Tab. Phyc.*; Leighton, *Lich. Fl.* 9; Rabenhorst, *Alg.* ii. 285.

SKELETON LARVA.—The larva of *Corethra plumicornis*, a dipterous insect, of the family Tipulidæ.

It is very transparent, and shows well the internal structure.

BIBL. Westwood, *Insects*, ii. 515; Pritchard, *Micr. Illustr.* 50.

SKELETONE'MA, Grev.—A genus of Diatomaceæ.

S. Barbadense, in the Barbadoes deposit. (Grev. *Micr. Tr.* 1865, 43.)

SKIN OR INTEGUMENT OF ANIMALS.—Three parts are distinguishable in the skin: an outer or cellular, forming the epidermis; an inner fibrous, or cutis vera; and an internal or subjacent, known as the subcutaneous cellular tissue. The two former constitute the skin proper.

The cutis vera or corium (fig. 641 *c*) consists of connective and elastic tissue, with fat-cells, blood-vessels, nerves, absorbents, and unstriated muscular fibres. The fibres of the connective tissue are variously interlaced and united into interwoven bundles, forming a tolerably dense and firm tissue, with small areolæ, and sometimes presenting laminæ. The elastic tissue is less abundant than the connective, and consists of networks of finer or coarser fibres.

The outer surface of the cutis gives off a number of conical processes or papillæ

(fig. 641 *e*), which are frequently bifid, lobed, or arise several from a common base. In many parts of the skin they are arranged in more or less regular rows.

In certain papillæ, the connective tissue is often homogeneous, especially in the median portion, where it forms an oval transparent body (fig. 642 *a*), surrounded by a layer of imperfectly developed elastic tissue, consisting of spindle-shaped cells and fibres taking a horizontal or circular direction, and giving the oval body a transversely striated or laminated appearance. These are called tactile corpuscles, and are most abundant at the ends of the fingers and in the lips. See also PACINIAN CORPUSCLES. The cutaneous papillæ are traversed by the terminal loops of the capillaries (fig. 642 *d*) and nerves (fig. 642 *c*).

The cutis is continuous beneath with the subcutaneous cellular or properly areolar tissue (fig. 641 *d*), which is of a much more lax texture than the cutis, presenting large areolæ filled in most but not all places with fatty tissue (fig. 641 *f*).

The cutis is everywhere covered externally with a thin membrane, and this by the epidermis, which is a semitransparent coat, containing neither vessels nor nerves, moulded as it were upon the surface (fig. 643) and filling up the intervals between the papillæ (fig. 644). The variously arranged lines seen upon its outer surface are depressions corresponding to those existing upon the cutis between its rows or groups of papillæ.

The epidermis consists entirely of nucleated cells; and two distinct layers are recognized in it (fig. 643), an inner forming the rete mucosum (fig. 643 *c*), and an outer or cuticle (fig. 643 *d*). The rete mucosum is softer than the cuticle, and is frequently of a brownish colour, from its cells, especially the deepest, containing granules of pigment. These cells are not all of the same form, those immediately applied to the cutis being somewhat elongated and

Fig. 641.

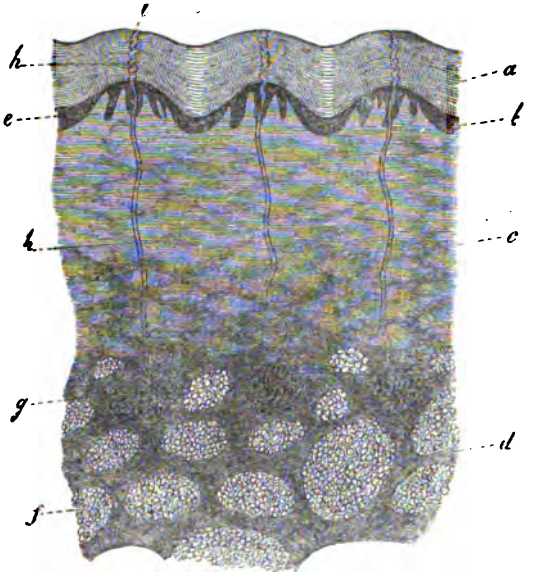


Fig. 642.

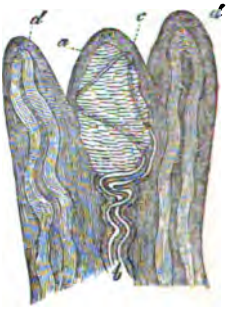


Fig. 641. Perpendicular section of the skin of the under surface of the end of the thumb, through three furrows. *a*, cuticle; *b*, rete mucosum; *c*, cutis vera; *d*, upper part of subcutaneous tissue; *e*, papillæ of the cutis; *f*, fatty tissue; *g*, sudoriparous glands; *h*, sudoriparous ducts; *i*, orifice of the latter. Magnified 20 diameters.

Fig. 642. Papillæ from the skin of the under part of the end of the finger. *a*, axial body; *b*, nerve; *c*, its terminal loop; *d*, *d*, loops of capillary blood-vessels. Magnified 250 diameters.

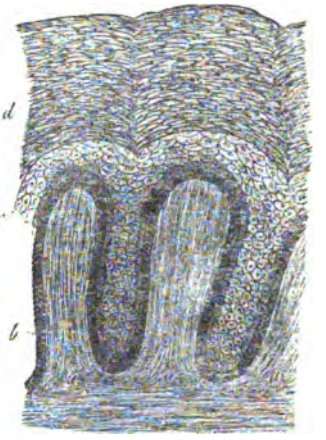
arranged perpendicularly upon its surface (fig. 643 *b*). The next are somewhat cubical; and their surface often exhibits flat processes or teeth, forming the so-called "prickle-cells." The cells of the next rows are polygonal, and contain one or more nuclei; they have a distinct cell-wall, and some have hair-like processes.

The cells of the cuticle are colourless, flattened, often wrinkled or folded, and correspond to the pavement epithelium of the mucous membranes. Between the epidermis and the cutis is situated a basement membrane, which is easily distinguishable.

In preparing the skin, it may be hardened by a mixture of chromic acid and alcohol, and stained with picro-carmine. By keeping a portion of skin in a digestive liquid, as pepsine and dilute muriatic acid, the connective tissue becomes transparent, and exhibits clearly the muscular and elastic fibres.

In the examination of the skin, sections must be made with Valentin's knife, and these treated with acetic acid, solution of potash, dilute nitric acid, &c. The blood-vessels are well seen, as regards general

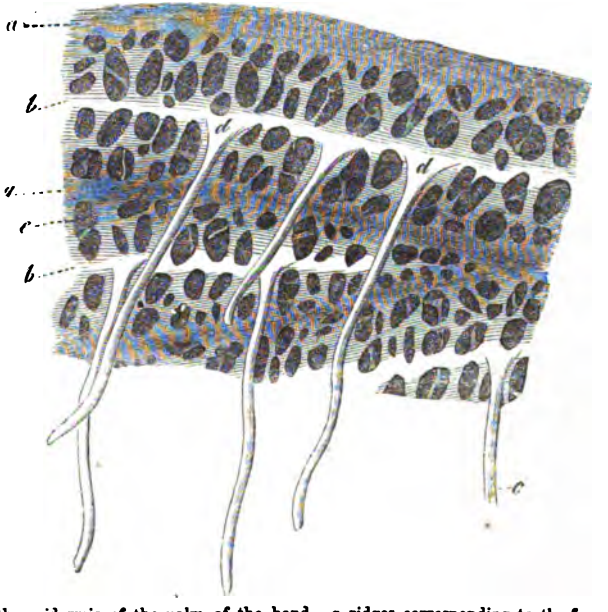
Fig. 643.



Perpendicular section of the skin of the Negro. *a*, papillæ of the cutis; *b*, deepest and most intensely coloured layer of elongated perpendicular cells of the rete mucosum; *c*, upper layer of the rete; *d*, cuticle.

Magnified 350 diameters.

Fig. 644.

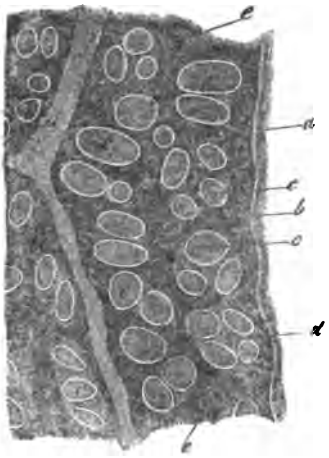


Under surface of the epidermis of the palm of the hand. *a*, ridges corresponding to the furrows between the ridges of the cutis; *b*, ridges corresponding to the furrows between the rows of papillæ; *c*, sudoriparous ducts; *d*, their broad insertions in the epidermis; *e*, depressions corresponding to the papillæ.

Magnified about 20 diameters.

arrangement, in injected preparations, some of which, as those of the pulp of the finger, form very beautiful objects. The epidermis is easily separated by maceration.

Fig. 645.



Section of the skin of the heel parallel to the surface, through one entire ridge of the skin and part of two others; showing the arrangement of the papillæ in rows corresponding to the ridges of the cutis. *a*, cuticle between the ridges; *b*, rete mucosum; *c*, papillæ; *d*, portion of the rete mucosum between papillæ arising from a common base; *e*, sudoriparous ducts.

Magnified 60 diameters.

The integument of animals is noticed under the respective heads of the classes.

It must be remarked that the terms epidermis and cuticle are generally used synonymously.

Bibl. Kölliker, *Mik. An.* i., and *Gewebelehre*; Todd and Bowman, *Phys. An.*; Meissner, *Beitr. z. An. u. Phys. d. Haut*, 1863; Biesiadecki, *Stricker's Hist.*

SLATE. See Rocks.

SMARIS, or Smaridia, Latr.—A genus of Acarina, family Trombidina.

Char. Palpi slender, inserted upon a retractile rostrum; mandibles sword-shaped; body entire, narrow anteriorly; coxæ stout, distant, the anterior articulated to a fixed eminence upon the body; legs palpatorial, used also as palpi, the anterior longest.

S. papillosa (Pl. 6. fig. 36; *a*, mandible). Body vermilion-coloured, broader in front, depressed, covered with short cylindrical papillæ rounded at the end. Fusiform scales replace the papillæ upon the legs, palpi, and rostrum.

Found upon the trunks of trees, and in moss.

Several other species are found in moss, upon fallen leaves, and on the *débris* left after inundations.

In *S. expalpis*, Koch, there are no palpi.

Bibl. Dugès, *Ann. Sc. N.* 2. i. 16 & 34; Gervais, *Walckenaer's Apt.* iii. 173; Murray, *Ec. Ent.* 149.

SMITTIA, Hincks.—A genus of Escharidæ (Cheilostomatous Polyzoa), = *Lepralia* sp., with the secondary orifice elevated, produced, and channelled in front. 7 species. (Hincks, *Polyzoa*, 340.)

SMUT. See Uredo.

SNAILS, WATER-.—Most microscopic observers, ever anxious to determine the unknown cause of the curious circulation or rotation (Rotation) taking place in certain water-plants, as *Vallisneria*, *Anacharis*, &c., keep these growing in large glass vessels, as confectioners' jars, or Vivaria. These plants, and the sides of the vessels, are however very apt to become overgrown and obscured by Confervoid Algæ (as *Œdogonium*), Palmellaceæ, &c., which may be prevented by keeping water-snails in the water, as species of *Limnæus*, *Physa*, *Bythinia*, *Planorbis*, &c. The latter are best for this purpose (the shell is flat-spiral). If Desmidiaceæ, Diatomaceæ, Infusoria, &c. are to be preserved, the snails must be carefully excluded, because many of these are consumed by them, and will not live, as the bottom of the vessels soon becomes covered, when snails are kept, with a load of excrement. The characters of the snails are too long to be given here. The gelatinous masses of ova are found adhering to water-plants.

See the *Bibl.* of Mollusca.

SNOW.—The various forms presented by ice or crystallized water in the form of snow constitute beautiful although fugitive microscopic objects.

The crystals belong to the rhombohedric or hexagonal system. Several hundreds of forms have been observed, and many of them figured. Among them may be mentioned hexagonal or dodecahedral plates; hexagonal prisms, single, arranged in a stellate form, or terminated by rectangularly placed plates or secondary groups of needles; hexagonal pyramids, &c. The angles of these forms frequently constitute secondary centres, around which other similar or dissimilar forms are aggregated. By some authors these forms are regarded as skeleton crystals.

See also Red Snow.

Bibl. Scoresby, *Arctic Regions*; Kämtz,

Meteorologie; Glaisher, *Mic. Jn.* 1855, iii.; Naumann, *Mineralogie*.

SODA.—Kölliker recommends a solution of caustic soda, in preference to potash, for the resolution of some of the tissues into their component elements. We have been unable to detect any marked difference between the action of these two solutions; and the former has the disadvantage of lifting the stopper from the bottle by the crystallization of the carbonate formed, so that it is with difficulty preserved.

Pl. 10. fig. 15 represents the crystals of oxalate of soda; and fig. 19 those of the nitrate (UREA).

SODIUM, CHLORIDE OF, or common salt.—The crystals of this salt belong to the regular system. The most common form is the cube terminated by quadrangular pyramids or quadrangular pyramidal depressions, rectangular tables, &c. Schmidt endeavours to show that the primary form of the crystals is the octahedron, and that the cubes are twin octahedra. The crystals do not polarize light. (Schmidt, *Entwurf ein. allg. Untersuch.* 90; and the *Bibl.* of CHEMISTRY.)

SŒMMERING, MIRROR OF.—INTRODUCTION, p. xxii.

SOLENOPH'RYA, Cl. & Lach.—A genus of Acinetina.

Char. Sessile and with a membranous lorica, tentacles simple, indistinct tufts. On roots of *Lemna*. (Clap. et Lach. *Inf.* 389.)

SO'LIUM, Heib.—A genus of Biddulphieæ (Diatomaceæ). (Rabenh. *Alg.* i. 319.)

SOLORI'NA, Ach.—A genus of Phyllodei (Lichenaceous Lichens). 4 species, in mountainous districts. (Leighton, *Lich. Fl.* 106.)

SORAS'TRUM, Kütz.—A genus of Desmidiaceæ.

Char. Frond globular, composed of compressed radiating cuneate cells, bifid at the apex.

S. spinosum (Pl. 3. fig. 22), in stagnant turf-pools.

BIBL. Kützing, *Sp. Alg.* 195; Rabenht. *Alg.* iii. 81; Carter, *Ann. N. H.* 1869.

SORITES, Ehr. See AMPHISORUS and ORBITOLITES.

SOROSPHÆ'RA, Br.—A free, Arenaceous Foraminifer, with numerous subglobular thin-walled chambers (1-5″ diam.), loosely attached, and irregularly crowded. *S. confusa*, in the Atlantic and Pacific, 900–2900 fathoms. (Brady, *Qu. Mic. Jn.* n. s. xix. 9.)

SOROS'PORA, Hass.—A genus of Palmellaceæ (Confervoid Algæ) not clearly distinguished from *Glœocapsa* and *Protococcus*. (Hassall, *Algæ*, 309.)

SOROTHE'LIA, Körb.—A genus of Microlichens, parasitic on the thallus of *Plyctis argena*. Spores 8, 2-locular, brown. (Lindsay, *Qu. M. J.* 1869, 343.)

SO'RUS.—The name applied to the aggregation of sporanges of the FERNS; sometimes applied also to the groups of spores in the Florideous Algæ.

SPATHID'IUM, Duj. = *Leucophrys* pt.

SPATHULA'RIA, P.—A genus of Discomycetes (Ascomycetous Fungi), with a fertile head running down the stem on either side. *S. flavida* is one of our prettiest Fungi when in perfection.

BIBL. Grev. t. 165; Berk. *Outl.* t. 21. fig. 7; Cooke, *Handb.* 661.

SPECTROSCOPE, OR MICROSPECTROSCOPE.—The spectrum-analysis of coloured microscopic objects may be effected by means of one or more prisms in connexion with the simple or compound microscope. The prism, or combination of prisms, may be placed, either beneath the achromatic condenser, in the body of the microscope, or in the eyepiece; and this last arrangement is usually adopted. Sorby and Browning have perfected the microscopic eyepiece.

Above the eye-glass of the eyepiece, which is made achromatic and capable of focal adjustment for rays of different refrangibility, is placed a tube containing five prisms, two of flint glass interposed between three of crown glass in such manner that the emergent rays which have been separated by the dispersive action of the flint-glass prisms are parallel to the rays which enter the combination. Below the eye-glass, in the place of the ordinary stop, is a diaphragm with a narrow slit, which limits the admission of light. Objects placed on the stage of the microscope, provided they transmit a sufficient quantity of light, may then be examined, and their spectra observed. If it is desired to compare their spectra with any other, provision is made for the formation of a second spectrum, by the insertion of a right-angled prism which covers one half of the above-mentioned slit and reflects upwards the light transmitted through an aperture in the side of the eyepiece. For the production of the ordinary spectrum, light is reflected into this aperture from a small mirror carried at the side; while for the production of the spectrum of any sub-

stance through which the light reflected from the mirror can be transmitted, it is only necessary to place the slide carrying the section or crystalline film or the tube containing the solution in the frame adapted to receive it. In either case this second spectrum is seen by the eye of the observer alongside of that produced by the object viewed through the body of the microscope, so that the two can be exactly compared. Some care is requisite in the arrangement and number of the prisms according to the amount of dispersive power required.

Crookes has devised a modification of this apparatus, in which the prisms and slit can be withdrawn and replaced without removing the eyepiece.

The spectroscope is of the utmost value in microscopic, as in other researches; but its study is very difficult, and we have no space to enter into its minute details.

Bibl. Sorby, *Qu. Jn. Sc.* ii. 198, *Proc. Roy. Soc.* xv. 433, *Mn. Mic. Jn.* xiii. 198 (*blood-stains*), and *Beale's How*, &c. 269; Lockyer, *Phil. Trans.* 1874, 481, and *Spectroscope*; Browning, *Spectroscope*; Schellen, *Spectroscope*; Proctor, *Spectroscope*; Huggins, *Tr. Mic. Soc.* 1865; Crookes, *M. M. Jn.* 1869, 371; Suffolk, *Spectr. Analys.*; Vierordt, *Sp. Anal., quant.*, 1876; Ward, *Jn. M. Soc.* 1878, i. 326 (*new spectroscope*); Palmer, *Mn. M. J.* xvi. 277 (*measurement*); McMunn, *Spectr. in. Med.* 1881.

SPERMATIA.—The minute corpuscles supposed to represent spermatozoids in the Lichens (Pl. 37. figs. 3, 15, 16) and Fungi (Pl. 26. figs. 2, 3, 4).

SPERMATOZOA of Animals.—The form of the spermatozoa varies in different animals (Pl. 50); but they usually consist of a rounded or oval body or head, to one end of which is appended a moveable filament. This is their form in man (fig. 25), and the Mammalia generally (figs. 26–28); the former exhibit an undulating membrane (Gibbes). In Birds, the body is sometimes cylindrical, sometimes spiral or presenting a zigzag outline (figs. 29–31).

In Reptiles, the body is usually cylindrical and straight (fig. 33), sometimes spiral; they are very large in *Amphiuma*; but in some of them, the straight or slightly undulating terminal filament is surrounded by a spiral fibre or Undulating Membrane (fig. 17). In some instances, the so-called undulating membrane consists of adherent portions of the formative protoplasm.

In Fishes, the spermatozoa are usually very small, and the body rounded, although in some the body is spiral (fig. 34).

In the Invertebrata, a distinct body and terminal filament are present in some; while in others each spermatozoon forms a simple filament tapering at the ends (fig. 32). In some instances, the body seems to exist as a short cylinder or rod; in others, the spermatozoa are represented by simple cells, or cells with radiating processes.

The development of the spermatozoa is not agreed upon. In the higher animals, the protoplasm of the peripheral cells of the seminal canals grows inwards into finger-like processes, called spermatoblasts. In each of these, a nucleus is formed, constituting the head of the spermatozoon, the protoplasm at the end of the process growing into the filament, so that each spermatoblast produces 8 or 10 spermatozoa. According to Kölliker, they are developed within the epithelial cells of the tubuli, nuclei or globules arising within these, in each of which a spermatozoon is found coiled up (Pl. 50. figs. 35, 36). In some animals, the spermatozoa are formed in bundles, the bodies and filaments lying parallel with and opposite each other (fig. 37).

Most spermatozoa exhibit active movements, produced by the action of the filament, whence they were formerly considered independent animals; but these movements are comparable with those of the ciliated zoospores of the Algæ, or the ciliated epithelium of animals; they are increased by the addition of caustic potash.

In some animals, tubular sheaths are secreted around the masses of spermatozoa while contained in the seminal apparatus, and called spermatophores. These, when discharged from the organ, are fixed by the male to the posterior end of the body of the female by means of a glutinous secretion.

The spermatozoa are the essential fertilizing elements of the liquid in which they are contained.

Spermatozoa may be best examined and preserved by washing them with distilled water, and drying them upon a slide.

Bibl. Kölliker, *Mik. An.* ii.; id. *Beitr. z. Kenntn. d. Geschlechts. d. wirb. Thiere*; Czermak, *Sieb. u. Köll. Zeit.* ii.; Wagner, *Todd's Cycl.* iv., art. *Semen*; id. *Physiology, by Willis*; Leuckart, *Wagner's Handwört. d. Phys.* iv. 819; Beneden, *An. Comp.*; Owsiannikoff, *Mn. M. Jn.* i. 312; Lankester,

Qu. Mic. Jn. 1871; St. George, *Stricker's Hist.* ii. 141, and the *Bibl.*; Klein, *Hist.*; Einer, *Phys. Med. Ges. Würtzburg*, vi. 93; Johnston, *M. Mic. Jn.* xvi. 61 (*Amphiuma*).

SPERMATOZO'IDS, or ANTHERO-ZO'IDS.—The terms applied to the structures produced in the antheridia of the Cryptogamia, regarded as analogous to the spermatozoa of animals, and as the agents of fertilization of the germ-cell. In the Marsileaceæ, Lycopodiaceæ, Equisetaceæ, Ferns (Pl. 40. fig. 34), Mosses (fig. 33), Hepaticæ (fig. 32), and Characeæ (fig. 31), they are ciliated spirally-coiled filaments, exhibiting very active spontaneous motion. In the Fucoid Algæ, they are globular cells bearing two unequal cilia moving actively. In the Florideæ they are minute globular cells (Pl. 4. fig. 12 *a*), and neither cilia nor movement have been demonstrated. In the Lichens and Fungi the spermatia (Pl. 26. fig. 4; Pl. 27. fig. 23; Pl. 37. fig. 15) appear to represent the spermatozoids of the other classes, and they seem to be devoid of spontaneous movement. The details respecting these bodies are given under their respective classes.

Bibl. Thuret, *Ann. Sc. Nat.* 3. xiv. 214, and xvi. 5; Schacht, *Sperm. im Pflanz.* 1864, & *Qu. Mic. Jn.* 1865.

SPERMOGO'NIA.—The supposed antheridial structures of Lichens (Pl. 37. figs. 2, 13, 15) and Fungi (Pl. 26. figs. 1 and 4).

SPERMOSI'RA, Kützing.—A genus of Nostochaceæ, growing in salt marshes, containing two British species; known from the other genera by the disk-shaped or lenticular cells; but the filaments are liable to be mistaken for a *Nostoc* in the young state.

Spermosira litorea, Kütz. (Pl. 3. fig. 20). Filaments 1-3600″ thick, straightish, æruginous; ordinary cells confluent, very short; sporangial cells at first green, depressed-spheroidal, 1-3000″ in diameter, granular, fuscous when mature; vesicular cells transversely elliptical, not wider than the ordinary cells. In muddy brackish ditches.

S. Harveyana, Thwaites. Filaments much curved; cells nearly as long as broad; sporangial cells exactly spherical, almost twice the diameter of the ordinary cells; vesicular cells subquadrate, rather longer than wide, about as wide as the ordinary cells. In muddy brackish ditches.

Bibl. Harvey, *Brit. Algæ*, 233, and *Phyc. Brit.*; Kützing, *Tab. Phyc.* i.; Rabenhorst, *Alg.* ii. 185.

SPHACELA'RIA, Lyngb.—A genus of Ectocarpaceæ (Fucoid Algæ), containing a number of species, two of which, *S. scoparia* and *S. cirrhosa*, are common. They have jointed, rigid, distichously branched, feathery filamentous fronds, of an olive colour, a few inches high, and are especially characterized by the *sphacelæ* formed at the ends of the branches. They multiply by zoospores produced in unilocular or plurilocular sporangia. The propagula are produced on the lateral branches, and are connected by a cell which may produce several of them. Each consists of a pedicel of three rays and of a multicellular pair. The rays and pedicel produce when they come into contact with those of another Alga, short shields like a prothallus, of which the peripheral cells may produce new plants.

Bibl. Harvey, *Mar. Alg.* 55; Janczewski, *Mém. Soc. Nat. de Cherbourg*, xvi. 337.

SPHÆ'RIA, Hall.—A genus of Pyrenomycetes (Ascomycetous Fungi), now somewhat reduced from its ancient limits, but still containing a vast number of species, which it is impossible to treat satisfactorily within our limits. The forms vary chiefly in regard to the perithecia, which are sometimes only covered by a veil, and hence appear superficial on the matrix, while in other cases they are imbedded in the matrix

Fig. 646.

Sphæria quaternata.
Three groups growing on a piece of beech wood.
Magnified 20 diameters.

(Pl. 26. fig. 25), only evident externally by the black papilla, which is permanent, becoming indurated, and opening by a pore to discharge the spores in a fine powder. Many of the immersed kinds are only evident externally as minute black points or dots upon the surface of the leaf, stem, &c. which they infest; others are exposed freely when mature, breaking out from beneath the epidermis. Sometimes they are solitary, sometimes associated in small or large numbers, distinct or confluent. *S. quaternata* (fig. 646) is an example of the occurrence of free perithecia grouped together, mostly in fours; being decumbent, their ostioles are collected together, and they perforate the bark by a little black rugged tubercle.

This is common on beech trees. *S. convergens* (figs. 647, 648) is an analogous form. *S. elongata* (figs. 655–657) affords an example of those species which are at first immersed and adnate, and finally burst forth and become nearly free.

Fig. 647.

Fig. 648.

Sphæria convergens.
Magnified 20 diameters.

Fig. 649.

Sphæria verrucosa.
Magnified 20 diameters.

For species now separated from this genus see CLAVICEPS, HYPOXYLON, XYLARIA, HYPOCREA, and NECTRIA.

Certain points of great interest have lately been ascertained respecting this genus and its allies, which are mentioned under the heads of the family and other genera, namely the coincidence and evident connexion between true species of *Sphæria* and various Coniomycetous Fungi; for just as *Melasmia* is a precursory form of *Dothidea*, *Tubercularia* of *Nectria*, &c., *Cytispora*, *Septoria*, and other forms precede *Sphæria*, and many distinct stylosporous forms are associated, usually described as belonging to distinct genera, such as *Stilbospora*, *Sporocadus*, *Sphæropsis*, &c. Thus these plants seem to produce three kinds of reproductive organs, as is now known to be the case with the Uredinei, viz.:—(1) a form analogous to the *spermogonia* of the Lichens (in *Sphæria* represented by *Cytispora*, &c.); (2) an ascophorous fruit, the perithecium of the true *Sphæria*; and (3) a stylosporous fruit, representing the genera *Stilbospora*, *Sporocadus*, &c.

S. Laburni has been found by Tulasne to exhibit all these stages, namely perithecia containing asci surrounding a cytispore, with other conceptacles on the same stroma resembling the perithecia, but lined with stylospores instead of asci. Berkeley and Broome also describe the existence of the perithecia of *Sphæria inquinans* and the conceptacles of *Stilbospora macrosperma* on the same stroma (Pl. 26. figs. 25–28).

It is stated by Tulasne that the spermatia of the cytisporous forms may be contemporaneous with the stylospores or basidiospores, but they always precede the ascospores in their development; hence there is ground for supposing that they represent the spermatozoids of the higher Cryptogamia. With regard to the relations of the stylospores, it is possible that they are merely modifications of the ascospores; but it would appear probable that they must be regarded as real gonidial structures, for which it may be desirable to retain Fries's name of *conidia*, just as that of *tetraspores* is retained among the Florideous Algæ. Attention should be directed here to the complete correspondence between the series of forms of these genera and those of the UREDINEI, where, as in PUCCINIA, we have the *spermogonium* (cytispore), the *uredo* (stylosporous fruit), and the *perfect fruit* (perithecium). See also CONIOMYCETES.

Currey has published some extensive observations on the spores of the *Sphæriæ*.

BIBL. Berk. *Br. Fl.* ii. pt. 2. 232; *Ann. N. H.* i. 205, vi. 360, 2. v. 374, vii. 186; *Hook. Jn. Bot.* iii. 319; Fries, *Sum. Veget.* 388, *Syst. Mycol.* ii. 319; Tulasne, *Ann. Sc. N.* 3. xv. 375 (*Ann. N. H.* 2. viii. 117), 4. v. 108, viii. 35; Currey, *Mic. Jn.* 1855, iii. 263, *Linn. Tr.* xxii. 267.

SPHÆRIACEI.—A family of Ascomycetous Fungi, containing a vast number of parasitic plants, mostly of minute dimensions, growing upon leaves, stems, bark, wood, &c., and sometimes on the bodies of insects. The essential distinctive character lies in the globular, ovate, or flask-shaped conceptacle or *perithecium*, containing asci, which ultimately opens by a pore at its summit to discharge the spores. These perithecia occur either solitary or in groups on an indistinct matrix, growing out from the epidermis of leaves, &c. (*Sphæria*); or they are immersed in a tubercular stroma (*Nectria*), while in the larger forms the stroma becomes developed into an erect clavate or bushy structure, of fleshy or horny consistency, the perithecia being imbedded in the superficial layer of this, and opening by pores on the surface. Much remains to be done in reference to the history of this family, not merely on account

of the polymorphous characters of the ascophorous forms, but from the circumstance that it has recently been shown, as was suspected before, that there is a relationship existing between them and the supposed genera of Coniomycetous Fungi of similar habit. These last are in fact mostly forms of Sphæriaceous Fungi, as is indicated under the heads CONIOMYCETES, ASCOMYCETES, DOTHIDEA, SPHÆRIA, CYTISPORA, SEPTORIA. Our treatment of this family is very imperfect, the knowledge of them being confined to few persons, and much of it lying scattered in fragments. British genera:

* *Stroma erect.*

Claviceps. Stroma simple, clavate; perithecia superficial, in a distinct layer at the summit of the clavate stroma; asci tubular; spores very long, multiseptate.

Xylaria. Stroma simple or branched; perithecia spread all over, often wanting at the summit, black; asci eight-spored; spores uniseptate.

Fig. 650. Fig. 651.

Fig. 652.

Xylaria guianensis.

Fig. 650. A stroma. Nat. size.
Fig. 651. Vertical section of the same. Nat. size.
Fig. 652. Section of a perithecium. Magnified 10 diameters.

Thamnomyces. Stroma branched, shrubby, or stalk-like; perithecia formed from the stroma, more or less naked; asci tubular; spores simple, ovate.

** *Stroma between erect and horizontal.*

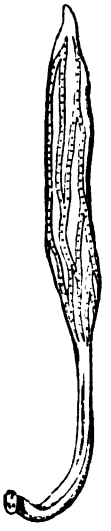
Poronia. Stroma cup-shaped, stipitate or sessile, margined; perithecia in the disk, superficial; ostioles even slightly prominent.

*** *Stroma horizontal.*

Hypocrea. Stroma distinct from the matrix, tubercular; perithecia immersed; asci filiform; spores simple or uniseptate.

Hypoxylon. Stroma distinct from the matrix, at first covered with a floccose mealy veil; perithecia black; asci linear-clavate; spores subseptate, expelled in a cloud of black powder.

Fig. 653. Fig. 654.



Xylaria grammica.

Fig. 653. Natural size
Fig. 654. Horizontal section. Magnified 5 diameters.

Diatrype. Stroma partly formed from the matrix, not distinct; perithecia deep-seated, produced into a long neck, and frequently a beak; spores simple and pellucid.

Dothidea. Perithecia undistinguishable from the stroma; asci collected into a globose nucleus with a neck above, leading to an ostiolate papilla.

**** *Stroma wanting; the perthecia often seated on a tuberculous, crustaceous, byssoid, macular mycelium.*

Nectria. Perithecia free, membranous, flaccid, brightly coloured, with a pale papilla, nucleus pale; asci eight-spored; spores pellucid.

Oomyces. Perithecia erect, several contained in a shining sac, free towards the upper part; ostiole punctiform; asci linear; spore filiform, very long.

Sphæria. Perithecia black, papilla covered by a veil or by the matrix, sometimes beaked, indurated, ostiolate, black; asci usually eight-spored; spores usually septate, discharged as a powder.

Fig. 655.

Fig. 657.

Fig. 656.

Sphæria elongata.

Fig. 655. Erumpent lines of perithecia. Nat. size.
Fig. 656. Portion of one in end view. Magnified 20 diameters.
Fig. 657. Asci and paraphyses from a perithecium. Magnified 200 diameters.

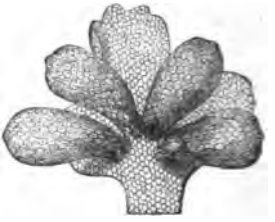
SPHÆROB'OLUS, Tode.—A genus of Nidularini (Gasteromycetous Fungi), consisting of a peridium of several layers, the inner one of which is suddenly reversed, and discharges the globose sporangia.

Bibl. Tul. *Fung. Hyp.* t. 21. f. 11; Berk. *Outl.* tab. 21. f. 2; Cooke, *Handb.* 412.

SPHÆROCAR'PUS, Kütz. = Staurocarpus.

SPHÆROCAR'PUS, Mich.—A genus of Ricciæ (Hepaticæ). *S. terrestris* (fig. 658) is a minute Liverwort growing on the ground, especially, it is said, in clover-fields. The fronds are from 1-4 to 1-2″ long, palish green, very thin and membranous, the lower surface adhering to the ground by radical hairs. The middle part of the upper surface bears a quantity of fruits, which consist at first of archegonia and antheridia, like those of other Liverworts, surrounded by a cup-like open perichæte (?), which gradually grows up over the fertilized archegonium and closes at the top, so as to form a pyriform sac, presenting an orifice at the summit. The archegonium ripens into a globular sporange, containing spores without elaters, crowned by a curious little styliform process. The spores are discharged by irregular rupture. The walls of the sporange are composed of simple parenchymatous cells, without spiral-fibrous layers. While the sporange is ripening, the perichæte enlarges into a loose, obconical, green membranous sac, through the thin walls of which the globular sporange is visible (fig. 658).

Fig. 658.



Sphærocarpus terrestris.

A frond with perichætes containing sporanges; one cut open.
Magnified 10 diameters.

Bibl. Hook. *Br. Flor.* ii. pt. 1. 103; Bischoff, *Nova Acta*, xiii. 150; Lindenberg, *ib.* xviii. 496; Fitt, *Hooker's Jn. Bot.* 1847, vi. 287.

SPHÆROCOC'CUS, Stackh.—A genus of Rhodymeniaceæ (Florideous Algæ), containing one British species, *S. coronopifolius* (Pl. 44. fig. 14), having a flat, linear, distichously branched frond of crimson colour and cartilaginous texture, of fan-like outline; parenchymatous, with an internal denser rib and cortical layer; 6 to 12″ long. The upper branches have their margins set with minute tooth-like processes, about 1-24″ long, in some of which the spherical conceptacles are imbedded.

Bibl. Harv. *Mar. Alg.* 128; Greville, *Alg. Br.* pl. 15.

SPHÆROIDI'NA, D'Orb.—A roundish, sublobate, hyaline Foraminifer, near *Globigerina*, but of denser structure, and folded somewhat like a *Miliola*. Recent and fossil.

S. austriaca (Pl. 24. fig. 4).

Bibl. Carpenter, *Introd. For.* 185.

SPHÆROM'PHALE.—A genus of Trypetheliæ (Angiocarpous Lichens), nearly related to *Verrucaria*.

SPHÆRONE'MA, Fr.—A genus of Sphæronemei (Stylosporous Fungi), characterized chiefly by the spores which emerge from the pore becoming glued together into

a firm globule. The species, which grow upon the surface of decaying plants, are probably only forms belonging to Sphæriaceous genera.

BIBL. Berk. *Br. Fl.* ii. pt. 2. 281; *Ann. N. H.* vi. 363, *ib.* 2. v. 371; Fries, *Sum. Veget.* 400.

SPHÆRONEME'I.—A family of minute Stylosporous Fungi, growing on bark, or more or less dry stems or leaves, characterized by the conceptacle ordinarily bursting by a pore or *ostiole*, or a lid, to extrude, in most cases, a gelatinous ball of filaments mixed with spores. From recent observations it appears that the genera do not consist of independent species, but are forms which occur in combination with Ascomycetous forms to complete the whole development of an individual,—the Sphæronemeous genera constituting the stylosporous or conidial fruits of Sphæriacei, &c., corresponding perhaps to the tetraspores found in the Florideous Algæ, which also possess proper spores (see SPHÆRIA). British genera:

Coniothyrium. Conceptacle free, membranous, opening by an irregular pore at the summit; spores globular.

Leptostroma. Conceptacle innate, subumbonate in the centre, dimidiate, at length falling off, leaving a very thin disk.

Phoma. Conceptacle ostiolate, very thin, innate, immersed, rounded, with a simple pore; spores oblong, simple.

Leptothyrium. Conceptacle operculate, innate, shield-shaped, not radiate-fibrous; spores spindle-shaped, simple.

Actinothyrium. Conceptacle operculate, innate, shield-shaped, radiate-fibrous; spores spindle-shaped, simple.

Microthecium. Conceptacle indehiscent, membranous, immersed, endophytic; spores simple.

Cryptosporium. Conceptacle membranous, opening irregularly at the summit; spores spindle-shaped, simple.

Sphæronema. Conceptacle horny, innate-superficial, more or less produced into a neck, ostiole simple; spores oblong, simple.

Acrospermum. Conceptacle leathery externally, fleshy within, elongate-clavate, ostiole simple; spores stick-shaped, simple.

Diplodia. Conceptacle horny, innate-superficial or immersed, perforated by a pore or irregularly opened or ostiolate, ostiole more or less produced; spores ovoid or ellipsoid, double, then halved into compressed-ternate semiellipsoid sporules.

Hendersonia. Conceptacle fleshy, superficially innate or immersed, perforated by a pore, opening irregularly or ostiolate, ostiole more or less produced; spores globose, cylindrical, or discoid.

Septoria. Conceptacle horny, innate-immersed, rounded, ostiole simple; spores cylindrical, septate.

Vermicularia. Conceptacle bristly, depressed, bursting irregularly; spores minute, linear.

Neottiospora. Conceptacles immersed; spores appendaged at one end with short hyaline threads.

Prosthemium. Conceptacle horny, immersed, ostiole simple; spores transversely septate, verticillate at the apex of their filaments.

Asteroma. Conceptacle very small, slightly prominent, close, subconfluent, seated on more or less distinct radiating fibrils.

Angiopoma. Conceptacles free, membranous, somewhat horny, cup-shaped, dehiscing by a circular mouth, provided with a fugacious epiphragm; spores affixed at the base, stalked, septate.

Discosia. Conceptacles innate, somewhat carbonaceous, at length collapsed and plicate, ostiole perforated; spores fusiform, produced at both ends into a thread-like point.

Piggotia. Conceptacles very irregular, thin, obsolete beneath, confluent into a rugulose patch, bursting by an irregular crack; spores on short stalks, largish, obovate, somewhat constricted towards the base.

Phlyctæna. Conceptacle spurious, formed by the blackened epidermis; spores fusiform, cuspidate, septate, emerging accompanied by a gelatinous mass.

Glœosporium. Conceptacle absent; spores covered only by the cuticle, which separates; spores stalked, longish, elliptical, simple, exuding a gelatinous tendril.

Dilophosphora. Conceptacle immersed in a spurious stroma, covered, perforated by a pore; spores cylindrical, continuous, crowded at both ends with radiating filiform appendages.

Sphæropsis. Conceptacle spherical, immersed, subinnate, astomous, at length (by the separation of the epidermis) bursting by circumscissile dehiscence or irregularly. Spores simple.

SPHÆROPH'ORON, Pers.—A genus of Epiconiodei (Lichenaceous Lichens). *Thallus* erect, shrubby, externally crustaceo-cartilaginous, internally solid and cottony.

Apothecia terminal, spherical, the perithecium, formed of the thallus, closed, dehiscing irregularly. Nucleus globular, internally floccoso-cartilaginous, the discharged (black) sporidia crowded in the circumference.

S. coralloides (fig. 395, p. 463), and *S. fragile*, common on sand-rocks, among mosses.

S. compactum is rare. The *spermogonia* occur at the ends of the more delicate branchlets of the thallus.

Bibl. Hook. *Br. Fl.* ii. pt. 1, 236; Leighton, *Lich. Fl.* 48; Tulasne, *Ann. Sc. Nat.* 3. xviii. 209.

SPHÆROPH'RYA, Clap. et Lach.—A genus of Acinetina.

Char. Tentacles simple, radiate; no sheath or peduncle; body free.

S. pusilla, small, spherical; freshwater. (Clap. et Lach. *Inf.* 385.)

SPHÆROP'LEA, Ag.—A genus of Confervaceæ of uncertain position, but probably allied to the Chætophoraceæ. It is characterized chiefly by the formation of the spores. The plants consist of simple filaments, with long joints, at first containing green colouring-matter excavated by large vacuoles, producing a banded appearance (Pl. 9. fig. 14 *a*), the contents in the fertile cells finally resolving themselves into numerous spinulose globular spores arranged in longitudinal rows (*b*), which become red when ripe.

The development of the spores of *S. annulina* has been observed by several authors; and Cohn has published an account of the formation of spermatozoids in distinct cells, exercising a fertilizing function. The filaments, which always terminate in pointed hair-like ends, present when actively vegetating the excavated or banded appearance of the green contents above noticed; the vacuoles separating the bands of a proper, colourless, mucilaginous coat. When about to produce spores the regularity of the bands vanishes, the vacuoles multiply in number in the substance of the bands, and the contents present the appearance of a green *froth* with starch-granules scattered through it. After a time a number of green corpuscles, the spores, appear in the median line of the cell; these assume a stellate shape, with radiating threads of protoplasm connecting them together; they soon appear in pairs, separated by transverse false septa, formed by the flattened vesicles of the vacuoles. The spores gradually become better defined, and the false septa disappear; then the young spores present themselves as globular bodies, devoid at this time of a cellulose coat. From two to six minute orifices are preceptible at this time in the partially softened wall of the parent cell. While these phenomena are occurring in some of the cells, a different change takes place in others. The green bands assume a reddish-yellow colour, their starch disappears, and they are gradually converted into myriads of short stick-shaped bodies, which break apart and "swarm" in vast numbers, filling the whole cell, moving actively in all directions. The gelatinous coat of some of the vacuoles sometimes remains intact; and these then lie free in the cavity of the cell, and are often carried about by the rapid motion of the corpuscles. Orifices are meanwhile formed in these cells also, through which the stick-shaped bodies (spermatozoids) escape into the water. Their length is about 1-3000″. The hinder end now appears somewhat swollen, and they bear two long cilia on the pointed beak—in fact resembling the *microgonidia* of the other Confervoids. Cohn states he has seen them accumulate around the orifices of the spore-cells, enter the cavities of these, and swarm about in the interior, in considerable numbers, at length adhering to the young spores. These resting-spores then acquire a membrane, and under this a second, which is at first smooth, but afterwards presents a spinulose or stellate appearance; the first coat is then thrown off, and a third, smooth coat appears under the stellate coat, closely investing the contents. These conditions resemble those of the spores of Spirogyra and other Confervoids; *Spirogyra*, however, retains the outer coat until germination. The green contents of the spores ultimately turn red. Their size and number in a cell vary much.

Cohn has also observed the germination of these spores, which is interesting in several respects. Their ordinary size is from 1-1200 to 1-1500″; and they present, as above mentioned, two coats, the outer elegantly marked; most authors describe it as stellate; Kützing asserts that it is spirally folded. The real fact is, that it is plaited in the direction of meridians from pole to pole, and thus appears stellate when seen at either pole, marked with lines when seen sideways. The spores do not appear to germinate until the spring following their production. The red contents begin to assume a green colour from the surface inwards, divided into two, then into four or eight portions, which break out from the spore-

cell, and swim about as free biciliated zoospores, of globular or shortly cylindrical form, from 1-2280 to 1-1680″ long, either bright red or particoloured red and green, the point bearing the cilia, however, always colourless. After a time they become coated with a cellulose membrane, cease to move, and grow into a spindle-shaped body, the ends prolonged into hair-like points. The growth appears to be always in the middle, the hair-like points remaining; thus the spindle-shape is retained until the length reaches 1-24″ or more, and the first septum appears in the middle of the filament.

S. annulina (Pl. 9. fig. 14) appears to be the only well-known form. It is a rare Conferva, growing on flooded fields; it does not seem to have been recorded in Britain.

For *Sph. crispa* and *punctalis*, see ULOTHRIX.

BIBL. Kütz. *Sp. Alg.* 362, & *Tab. Phyc.*; Braun, *Verjüngung*, *Ray Soc.* 1853, 165; Cohn, *Ber. Berlin. Ak.* 1855; *Ann. Sc. Nat.* 4. v. 187; *Am. N. H.* 2. viii. 81; Cienkowski, *Bot. Zeit.* xiii. 777; Rabenht. *Alg.* iii. 318.

SPHÆROPSIS, Lév.—A genus of Sphæronemei (Stylosporous Fungi), growing upon stems, &c.; apparently only stylosporous forms of Sphæriaceous genera.

BIBL. Fries, *Sum. Veget.* 419; Tulasne, *Ann. Sc. Nat.* 4. v. 115.

SPHÆROP'TERIS, Wall.—A genus of Dicksonieæ (Polypodiaceous Ferns). *S. barbata*; India. (Hooker, *Syn.* 49.)

SPHÆROSIRA, Ehr. See VOLVOX.

SPHÆROTHE'CA.—A genus of Sphæriacei (Ascomycetous Fungi), closely allied to *Erysiphe*. *S. pannosa* is common on the leaves and fruits of a rose; *S. Castagnei*, on the leaves of hops &c. (Cooke, *Handb.* 645; Tulasne, *Carp.* i. 208.)

SPHÆROT'ILUS.—A genus of Cryptococceæ, consisting of cells arranged in rows, connected by mucus, forming a flocculent, variously divided floating layer. *S. natans* (Pl. 3. fig. 21), brownish, in organic liquids: said to purify the water.

BIBL. Rabenht. *Alg.* ii. 8; Eyferth, *Jn. Mic. Soc.* 1881, 97.

SPHÆROZOS'MA, Corda.—A genus of Desmidiaceæ.

Char. Filamentous; filaments flat, fragile, their component cells closely united by means of minute (glandular) processes, and deeply divided on each side into two segments.

S. vertebratum (Pl. 14. fig. 9, front view; fig. 10, side view). Cells about as long as broad; connecting processes oblique, one on each side. Length of cell 1-1430″. Not uncommon in ditches.

S. excavatum. Cells longer than broad; connecting processes sessile, two on each side. Length of cell 1-2570″.

After separation, the cells conjugate; sporangia elliptical. Other species.

BIBL. Ralfs, *Br. Desmid.* 65; Rabenht. *Alg.* iii. 148.

SPHÆROZO'UM.— A genus of Radiolarian Rhizopoda.

It consists of a spherical group of rounded bodies consisting of sarcode with distinct nuclei, surrounded by a zone of siliceous spicules, the whole being imbedded in a common gelatinous matrix. The centre of the mass is vacuolated; and the whole often becomes a hollow sphere. (Huxley, *Comp. Anat.*; Carpenter, *Microscope.*)

SPHÆROZ'YGA, Agardh (*Anabæna*, Bory, Brébisson).—A genus of Nostochaceæ, differing from the allied genera only in the sporangial cells being separated by vesicular cells. As the sporangial cells are developed from the ordinary cells, and this gradually, the vesicular cell will appear at certain epochs to have a sporangial cell on one side and an ordinary cell on the other; but this arises merely from the fact that the sporangial cells are developed singly and successively, first one on one side of the vesicular cell and then one on the other, and so on, to whatever number of adjacent sporangial cells there may be developed on either side of the vesicular cell; and those nearest the latter will therefore always be the largest, until the whole have acquired the full size. Ralfs describes seven British species.

* *Filaments moniliform; sporangia elongated, not turgid.*

S. Carmichaelii. Filaments with tapering extremities; ordinary joints distinct, subquadrate; sporangial cells oblong; vesicular cells spherical.—Ralfs, *Ann. N. H.* 2. v. pl. 8. fig. 7; Harvey, *Phyc. Br.* pl. 113 A; *Mar. Algæ*, 2. ed. pl. 27. fig. D.

Belonia torulosa, Carmichael; *Sphærozyga compacta*, Kütz.; *Anabæna marina*, Brébisson; *Cylindrospermum Carmichaelii*, Kütz. *Sp. Alg.* 294, *Tab. Phyc.* i. pl. 99.

Var. *tenuissima*, with very slender filaments. Forming a tender, very thin stratum of a dark or bluish-green colour, on the damp soil of salt-marshes flooded at spring

tides, more rarely in brackish ditches, or upon decaying marine Algæ.

The best distinctive marks of this species are, the subacute extremities, combined with the short filament and littoral habit.

S. Jacobi. Filaments elongated, their ends usually attenuated; ordinary cells subspherical; vesicular cells spherical; sporangial cells oblong or cylindrical.—Ralfs, *l. c.* pl. 8. fig. 8; *Eng. Bot.* 2826. fig. 2. Forming thick, bluish-green, gelatinous masses, from which the filaments issue in long rays. Fresh-water.

S. elastica (Pl. 8. fig. 3). Dissepiments conspicuous; ordinary cells quadrate; vesicular cells elliptic; sporangial cells cylindrical, truncate.—Ralfs, *l. c.* pl. 8. fig. 9. *Cylindrospermum elongatum*, Kütz. *Tab. Phyc.* i. pl. 99. fig. 3. Forming a tender stratum, of a deep bluish colour, in bogs.

** *Filaments moniliform; sporangia turgid, much broader than the ordinary cells.*

S. Broomei, Thwaites. Filaments elongated; ordinary cells suborbicular; vesicular cells barrel-shaped or elliptic; sporangial cells elliptic, catenate.—Ralfs, *l. c.* pl. 7. fig. 10. Forming a firmish bluish- or yellowish-green stratum in brackish ditches.

S. Berkeleyana, Thwaites. Ordinary cells spherical or slightly compressed; vesicular cells spheroidal, compressed, as broad as the large, turgid-elliptic, sporangial cells.—Ralfs, *l. c.* pl. 8. fig. 11. In brackish ditches.

S. Mooreana, Ralfs. Ordinary cells subspherical; vesicular cells barrel-shaped, much narrower than the large, broadly elliptical sporangial cells.—Ralfs, *l. c.* pl. 8. fig. 12. An Irish species.

*** *Dissepiments obscure; cells longer than broad.*

S. leptosperma (Kützing). Filaments elongated, not constricted at the dissepiments; ordinary cells longer than broad, confluent; vesicular cells elliptic; sporangial cells linear.—Ralfs, *l. c.* pl. 8. fig. 13. *Cylindrospermum leptospermum*, Kützing, *Tab. Phyc.* i. pl. 99. fig. 2. Forming large shapeless gelatinous masses in still waters, varying from deep green to yellowish green, or, when the filaments are comparatively few, nearly colourless. Distinguished especially by the "confluent ordinary cells with obscure dissepiments."

SPHAGNA'CEÆ.—A family of Cladocarpous Mosses, of peculiar habit, growing in bogs &c., distinguished especially by the mode of branching, the structure of the leaves, sporanges, and antheridia, and by the absence of roots, except in the early stages of growth.

The stem of the *Sphagna* is composed of three layers of cells,—a cortical, a medullary, and an intermediate prosenchymatous layer, which finally becomes somewhat woody. The primary axis is indefinite in its growth; the lateral axes, sterile or fertile, are annual. The secondary axes are fasciculate; and being pendent or recurved upon the stem, they fulfil in some measure the function of roots. The leaves are remarkable for their cellular structure, being composed of two kinds of cells—namely, narrow and elongated cells filled with chlorophyll, conjoined into a kind of network, the meshes of which are occupied by large hyaline cells. The hyaline cells contain, in all but one exotic species, a spiral or annular secondary deposit (Pl. 48. fig. 25) characteristic of this family. These large cells also become opened by regular circular pores at a certain stage of growth.

The inflorescence is monœcious or dicœcious. The antheridia are produced singly in the axils of perigonial leaves at the club-shaped tips of short branches. They are pedicellate and roundish, like those of the Liverworts; they produce biciliated spermatozoids. The archegonia are found about four together, sessile, in a tuft of perichætial leaves occupying the axis of a fascicle of branches, the receptacle subsequently elongating into a peduncle, bearing a globular capsule, entirely surrounded by the calyptra. The calyptra is ruptured near the middle, the lower part persistent and continuous with the fleshy vaginule, within which the capsule is seated on a bulb-like pedicel; peristome none; operculum flattish, thrown off with elasticity. Spore-sac wanting; columella short, not reaching the mouth of the capsule. Spores apparently of two kinds, some enclosed four together in parent cells, others smaller, sixteen in one parent cell; the former fertile, the latter sterile, occuring either together or in distinct capsules. The spores in germinating produce a Marchantioid body, very different from the confervoid mass of ordinary mosses.

British Genus.

Sphagnum, Dill. Character that of the order. Nine species occur in Britain, some common on every bog, distinguished by

their brilliant yellow-green colour and the wet, spongy character of the beds they form. The leaves are very interesting microscopic objects.

Rotatoria are sometimes found in the cells of the leaves. Also upon or within the same, the curious parasitic Rhizopod—*Chlamydopyxis labyrinthuloides*. This, in the resting-stage, consists of a laminated thick-walled cellulose red or green cell. As the organism grows, it bursts the cell-wall, and the protoplasm issues in the form of numerous very slender radiating filaments, along which glide minute fusiform bluish-green amœboid bodies. It seems to bear analogy with the Myxomycetes.

BIBL. Wilson, *Bryol. Br.* 14; Schimper, *Ann. Sc. Nat.* 4. i. 313; Braithwaite, *Mosses*; Archer, *Qu. M. Jn.* 1875, xv. 107 (*Chlamydopyxis*); Husnot, *Sphag. Europ.* 1882.

SPHAGNOCŒ'TIS, Nees.—A genus of Jungermannieæ (Hepaticæ), containing one species, *S.* (*Jung.*) *Sphagni*, an elegant little plant growing over *Sphagnum* and other mosses on bogs; attaching itself by long radicles, numerous on the under side of the procumbent, nearly simple stem. The gemmiferous branches only have amphigastria.

BIBL. Hook. *Br. Fl.* ii. pt. 1. 113; *Br. Jung.* pl. 33, and Suppl. pl. 2; Ekart, *Syn. Jung.* pl. 6. figs. 43 & 48.

SPHENE. See ROCKS.

SPHENEL'LA, Kütz.—A genus of Diatomaceæ.

This genus appears to consist of the detached frustules of *Gomphonema*. Kützing describes seven species. *S. vulgaris* (Pl. 19. fig. 19).

BIBL. Kütz. *Bacill.* 83, *Sp. Alg.* 62; Rabenht. *Alg.* i. 282.

SPHENODE'RIA, Schlum.—A doubtful genus of Arcellina (Rhizopoda).

It is allied to *Euglyphe* and *Trinema*.

BIBL. Pritchard, *Infusoria*, p. 557.

SPHENOM'ONAS, Stein.—A genus of Flagellate Infusoria. Free, surface hard; flagella two, one long, one short; a tubular pharynx. Two species; freshwater. (Kent, *Inf.* 438.)

SPHENOSI'RA, Ehr., Kütz.—A genus of freshwater Diatomaceæ. DIATOMACEÆ, p. 244.

S. catena (Pl. 17. fig. 26).

BIBL. Kützing, *Sp. Alg.* 68; Rabenht. *Fl. Eur. Alg.* i. p. 293.

SPHINCTOCYS'TIS, Hass., = CYMATOPLEURA, Sm.

SPHINCTRI'NA.—A genus of Calyciei (Lichenaceous Lichens), with little stalk-like excipula and scarcely distinguishable thallus, growing on leaves or *Pertusariæ*. (Leighton, *Lich. Fl.* 38.)

SPICULA (plural of *spiculum*).—In some of the lower Invertebrata, firmness is given to the body by a kind of internal and external skeleton consisting of a number of curiously shaped microscopic bodies, many of which are of a needle-like form, often containing a cavity, and denominated spicula. They are met with in endless variety of form in sponges (see SPONGIDA) (Pl. 45, the lettered objects), where they usually consist of silex, some being of carbonate of lime. They also occur as anchors &c. in the Echinodermata (Pl. 45. figs. 1 *h*, *i*, *k*, *l*, and 19 *a*, *b*, *c*), the Foraminifera (Pl. 23. fig. 24), and in some of the Zoophytes (*Alcyonium*) and Mollusca (*Doris*), in these instances being calcareous.

There can scarcely be doubt that spicula are homologous with the elements of shell; but little or nothing is known of their development. They form very interesting microscopic objects, on account of their remarkable forms.

To prepare them, the animal substance in which they are contained should be boiled with nitric acid if they are composed of silex, and with dilute solution of potash if they consist of lime-salts. They may be preserved by mounting in Canada balsam.

They are commonly met with in sea-mud, and as fossils in some rocks.

SPIDERS. See ARACHNIDA.

SPILOCÆA, Fr.—A genus of Torulacei (Coniomycetous Fungi). *S. Pomi* occurs upon apples, in contiguous effused patches, from which the epidermis separates in fragments, exposing the simple globular spores, adherent to each other and to the matrix.

Probably only a state of *Cladosporium*.

BIBL. Berk. *Br. Fl.* ii. pt. 2. 380; Fries, *Sum. Veget.* 482.

SPILONE'MA, Fries.—A genus of Collemaceous Lichens.

Char. Thallus filiform, branched, fruticulose, granula gonima large, in transverse strata. Apothecia lecideine, lenticular. Spermatia shortly cylindrical. 3 species, on rocks. (Leighton, *Lich. Flora*, 10.)

SPINAL CORD.—The spinal cord of man is that part of the central nervous system which extends downwards from the medulla oblongata, occupying much of the vertebral canal, and terminating in a conical extremity at the level of the first lumbar

vertebra. The cord is composed of white substance, grey substance, and blood-vessels (Pl. 52. fig. 7).

The white substance (*a*) is mostly external, and forms the antero-lateral and posterior longitudinal columns, besides the transverse anterior commissure at the end of the anterior longitudinal fissure. It is composed of nerve-fibres of large and medium size, of connective tissue, and blood-vessels. The grey substance (*c*) is internal, and in transverse section of the cord presents a shape which may be roughly compared with that of the letter H. On either side there is an anterior and posterior horn or cornu; and the median line of the letter is represented by a soft grey commissure perforated by a canal, which is central and lined with epithelium. Surrounded on all sides by the white substance, the anterior and posterior spinal nerves reach their respective cornua by crossing at different angles along two lines on either side of the general direction of the nerves of the white substance.

The grey substance contains a large number of very fine nerve-fibres, which are united in a plexiform manner with nerve- or ganglion-cells; most of these fibres pass outwards and become spinal nerves, belonging then to the white substance or to distinct nerves. There is moreover granular matter with highly refractive globules, and extremely small nucleated cells surrounding the nerve-fibres and ganglion-cells. Much connective tissue exists in the neighbourhood of the central canal and in the posterior cornu.

The examination of the spinal cord and the brain is so difficult and not likely to be the subject of general investigation, that we must refer to the BIBL. for further details.

BIBL. Todd's *Cycl. An. & Phys.*; Lockhart Clarke, *Phil. Tr.* 1858, 1868; Stricker's *Hist.* ii.; Frey, *Hist.*, and the *Bibl.*

SPINES OF ANIMALS.—These are properly stout rigid and pointed processes of the integument, formed externally by the epidermis, and internally of a portion of the cutis or corresponding structure; but the term is frequently applied to stout rigid and pointed processes of the epidermis only.

See HAIRS, and the notices of the structure of the integument under the heads of the various classes.

SPIRACLES or STIGMATA of animals.—The external orifices of the tracheæ of Insects and Arachnida. The respiratory tubes of these animals have no communication with the mouth, but terminate externally in orifices situated upon the surface of the thorax or abdomen. These are mostly rounded or elliptical (Pl. 35. figs. 3, 7, 8, and 9 *a*), sometimes in the form of small clefts, and are often furnished with a kind of moveable valve, or bounded by a thickened rim; sometimes a sieve-like structure (Pl. 34. fig. 34) prevents the admission of foreign bodies, or they are surrounded by hairs or scales effecting the same purpose.

They are often situated at the lateral and upper portions of the abdomen, at the posterior, lateral, and upper part of the thorax, &c.

See ARACHNIDA, INSECTS, and the genera.

SPIRAL STRUCTURES OF PLANTS.—Among the most elegant of the microscopic objects furnished by the Vegetable Kingdom are the various forms of the secondary deposits upon the walls of cells, vessels, and ducts, &c., which present the appearance of fibres coiled into perfect spirals, or of spiral fibres either with the coils detached and forming rings, or with the coils more or less connected by cross pieces, producing a reticulated structure.

Under the head of SECONDARY DEPOSITS it is stated that this spiral-fibrous deposit may be taken as the character of a group of structures to be contrasted with those structures described as PITTED; and that the essential distinction in the nature of these two groups lies in the greater extent to which the primary wall is covered in the pitted structures. This is not quite absolute in reference to all spiral-fibrous structures, as in the true unrollable spiral vessels and similar organs the coils of the spiral fibres are often closely in contact, although not adherent to each other. It has been stated that the various forms of the open spiral, annular, and reticulated deposits are modifications of the simple close spiral; but this must be understood only in a morphological sense, since there is no actual change of condition ensuing with age, as has been assumed by some authors, the fibrous layers being always originally deposited on the primary wall in the form and pattern which they ultimately possess. There appears to be no real opening of the spirals or breaking up into rings, in consequence of the expansion of the primary wall to which they are attached.

It will be convenient, in the first place, to speak of the distinct well-marked structures ordinarily known as spiral cells and vessels, occurring in the stems, leaves, &c. of the higher plants, before describing certain other forms found in special organs, and to reserve to the end some points relating to the ultimate constitution of the secondary membranes of cells. Spiral structures are usually divided into *true spiral*, *annular*, *reticulated*, and *scalariform* organs.

Spiral cells and vessels are perhaps the most generally diffused of the forms. The name spiral vessel is given to elongated cylindrical cells tapering to a point at both ends, with a spiral-fibrous deposit lining the primary wall (fig. 659, and Pl. 48. figs. 8, 11, 12). The spiral fibre may be either single, as is most common, double (fig. 659); or

Fig. 659.

Fig. 660.

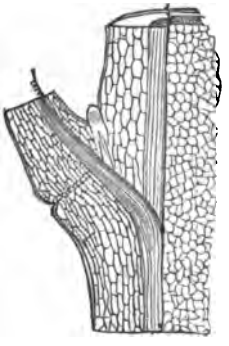


Fig. 659. Fragments of spiral vessels from the Melon. Magnified 200 diameters.

Fig. 660. Magnified diagram of a section of the base of a leaf-stalk arising from a Dicotyledonous shoot, showing the position of the spiral vessels in the leaf-stalk and next the pith of the shoot, the spiral fibres being uncoiled and a little drawn out.

a number of fibres may run parallel (*Musa*, *Nepenthes*, *Zingiberaceæ*, *Marantaceæ*). These spiral vessels occur as the first vascular formation outside the pith (MEDULLARY SHEATH) in almost all the Dicotyledons (fig. 660), and as the first vascular formation in the vascular bundles of the stems of Monocotyledons—also of all other vascular bundles, forming the ribs or veins of petioles, leaves, bracts, sepals, petals, &c. In the internal organs they can only be observed in sections, or when extracted by maceration: in delicate vessels and petals they may often be observed through the transparent epidermis. The coiled spiral fibre is mostly elastic enough to bear stretching open like a wire spring; in this case the primary wall is torn between the coils, and its ragged edges may sometimes be detected. The uncoiled fibres are often seen still unbroken when a hyacinth or similar leaf is broken across and the pieces gently drawn apart. *Annular* vessels closely resemble the preceding, except that the fibrous deposits are in the form of detached rings (fig. 661); they are the rarest forms; they are especially remarkable in the Equisetaceæ. The *reticulated*, again, have irregular spiral coils or rings connected more or less by perpendicular or oblique bars (fig. 662, and Pl. 48. fig. 9) into a network. These two modifications are usually of larger diameter than the true spiral vessel, and the reticulated larger (also of later origin in the organs) than the annular. However, mixed forms occur not uncommonly, partly annular, partly spiral or reticulated (fig. 663). They are found in similar situations, but generally do not extend into the more delicate organs. Spiral, annular, and reticulated vessels may be prepared in most beautiful forms and large size from portions of the leaf-stalk of rhubarb, of the stem of the garden-balsam, the melon, &c.

Fig. 661. Fig. 662. Fig. 663.

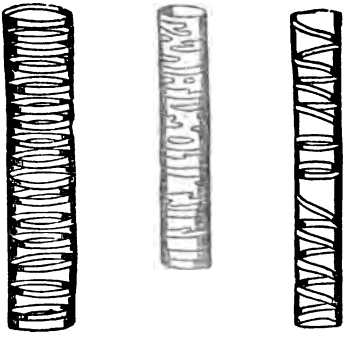


Fig. 661. Fragment of an annular vessel from the Melon. Magnified 200 diameters.

Fig. 662. Portion of a reticulated vessel from the Melon. Magnified 200 diameters.

Fig. 663. Fragment of a spiral and annular vessel from the Melon. Magnified 200 diameters.

Spiral and other vessels are usually simple

at first (branched *spiral* vessels do occur, more rarely), but ordinarily unite together by a kind of fusion. The conical extremities overlap to a certain extent (fig. 659); and thus the articulation is more or less oblique. This fusion is much more evident and complicated in roots, rhizomes, and abbreviated stems than in stems with developed internodes. The elementary cells are then generally much shorter; and the vessels formed from them branch out in various directions through the tissue. This is very well seen in the roots of many herbaceous plants, such as the dandelion, chicory, &c., and at the point of origin of the vascular bundles of adventitious roots generally.

The above-mentioned confluent spiral vessels pass insensibly into the *ducts*, which are similar confluent rows of cells forming parts of the solid wood of stems, composed of cells with flat ends applied together. They may resemble in their markings the preceding forms, but in their varied conditions form a series leading towards the PITTED DUCTS. The *scalariform* vessels or ducts (fig. 664, and Pl. 48. fig. 10), so called from the ladder-like markings, are a very regular form of the reticulated type—this regularity appearing to depend, however, upon the relation between the markings of the adjacent organs. In the PITTED DUCTS we find the pits only opposite to other pits, therefore on the sides adjacent to other ducts or to cells; in the scalariform ducts a spiral-fibrous deposit is conjoined into a network by vertical fibres placed opposite the intercellular passages or the meeting angles of contiguous cells or ducts, leaving regular slit-like spaces opposite the cavities of the adjacent cells. This form is especially characteristic of the Ferns; but it occurs also commonly in the Dicotyledons in a less regular form, passing quite insensibly into PITTED DUCTS, as in the wood of *Eryngium maritimum* (Pl. 48. fig. 21). The scalariform vessels of Ferns are often slightly unrollable.

Fig. 664.

Fragments of scalariform vessels from a Fern. Magnified 200 diameters.

It is mentioned under PITTED STRUCTURES, also, that a combination of the two types sometimes occurs in the same cell. This is the case in the ducts of the Lime, Mezereon, and other plants (Pl. 48. figs. 4, 13, & 19).

Besides the generally diffused spiral and other vessels and ducts above described, cells, properly so called (that is, such as never become elongated very greatly in one particular direction), belonging to particular organs and plants, present the same kind of markings. The ducts and vessels, indeed, in many cases are formed of very short cellular elements; but these may be distinguished from proper cellular tissue characterized by spiral secondary deposits. Under this head may be cited first certain *wood-cells*. In the Cactaceæ, the prosenchymatous tissue of the stem presents remarkable spiral and annular cells, in which the fibre becomes so much thickened that it projects like a riband set with its edge against the cell-wall (Pl. 48. fig. 7). The wood of the Mistletoe (figs. 665, 666) also exhibits spiral-fibrous cells: that of the Yew (TAXUS) is composed of true spiral-fibrous cells and others with bordered PITS and an internal spiral fibre in addition (Pl. 48. fig. 4). In the stems of the Leguminosæ, parenchymatous portions occur in the midst of the wood, the cells of which exhibit spiral fibres (*Ulex*, *Spartium*). The cellular tissue near the surface of the roots of the epiphytic Orchids (Pl. 48. fig. 6) affords another example, as also some of the subepidermal cells of the leaves (fig. 667). The layers of

Fig. 665. Fig. 666. Fig. 667.

Fig. 665. Annular-fibrous cell from the stem of Mistletoe. Magnified 200 diameters.
Fig. 666. Cell intermediate between reticulated and pitted, from the Mistletoe. Magnified 200 diameters.
Fig. 667. Spiral-fibrous cell from the leaf of an Orchid. Magnified 200 diameters.

cells lining the ANTHERS of Flowering plants are characterized by most varied patterns of spiral markings (Pl. 40. figs. 1–5); in these cells, moreover, we sometimes see the connexion between the fibrous and homogeneous deposits well illustrated, as the cells may have one or more sides marked with spiral fibres, while the remainder of

the wall is covered with a continuous layer. A similar structure, generally with perfect spiral fibres, occurs in the walls of the sporanges of *Jungermannia*, *Marchantia* (Pl. 40. fig. 35), and other Liverworts. With these are nearly connected the structures called ELATERS, which are found mixed with the spores in the same plants. These are tubular cells containing a single or double elastic spiral fibre (Pl. 40. figs. 36–38), exactly analogous to the spiral vessel in structure. Elaters of similar nature occur even among the Fungi, as in the sporange of TRICHIA (Pl. 40. figs. 39, 40). The elaters of the Equisetaceæ (fig. 205, p. 300) are of different character, consisting of four short filaments with clavate ends, attached at one side of the spore and originally coiled round it, ultimately unrolling with elasticity. They appear to be formed by the deposition of a spiral-fibrous layer on the wall of the parent cell of the spore, within which the true (single) spore-membrane is formed, unadherent; and when the spore is ripe, the spiral-fibrous layer splits up and starts away from the inner coat. An elegant spiral and annular fibrous structure is also met with in the large cells of the leaves of the SPHAGNACEÆ (Pl. 48. fig. 25); this is exactly analogous to the similar deposits in the higher plants. Spiral layers are found, less distinctly, in the radical hairs growing from the lower surface of the frond of MARCHANTIA. Nägeli regards them as folds of an inner layer of membrane; but they appear to be regular secondary deposits.

Lastly, the hairs and similar epidermal appendages sometimes exhibit spiral-fibrous deposits. An unrollable spiral fibre is beautifully arranged in the cells forming the mealy coating of the seed of *Cobæa scandens* (Pl. 28. fig. 20). The seeds of many of the Acanthaceæ (figs. 21 & 24), *Collomia* (fig. 22), the pericarp of some of the Labiatæ (fig. 23) and Compositæ (SENECIO) bear tubular hairs, consisting of cells with a spiral or annular fibre in their interior (see HAIRS of Plants). The structure of the hairs of *Collomia*, *Ruellia*, &c. has been much discussed, but it seems very simple: they appear to consist of a short tubular cell, upon the wall of which a closely coiled elastic spiral-fibrous layer is deposited; during the ripening of the seed the primary membrane undergoes a metamorphosis into a substance related to amyloid (or bassorine ?), which softens and swells up when placed in water, allowing the spiral fibre to extend itself (Pl. 28. figs. 21, 22 *b*, *c*). Sulphuric acid and iodine give the swollen gum-like envelope a purplish tint.

Another and less distinctly marked spiral arrangement of the substance of the cell-walls occurs in the form of cracks or gaps in certain of the layers of the secondary deposits, running more or less round the cell, appearing like irregular spiral streaks; these are sometimes present in the earlier secondary layers and not in the later, so that the "cracks" are covered in by the latter and converted into canals in the substance of the cell-wall. These occur in the wood-cells of *Hernandia sonora*, in the prosenchymatous cells of the vascular bundles of *Caryota urens*, *Phœnix*, *Metroxylon*, and probably in other cases. Something similar may be detected in the wood-cells of *Pinus* (Pl. 48. fig. 1), especially after treatment with boiling nitric acid. In liber-cells a spiral texture is far more generally evident. In *Vinca*, for instance (Pl. 48. fig. 30), and other Apocynaceous plants, a delicate spiral striation of the wall is evident in its natural state, beautifully regular in its arrangement; a similar appearance may often be detected in the walls of thickened hairs, especially when acids are applied, as in Cotton (Pl. 28. fig. 1 *b*), particularly in gun-cotton (fig. 1 *c*)—sometimes with intermediate slits, as in *Urtica* (fig. 8), &c.; and by boiling with nitric acid, a minute spiral-fibrous structure may be detected in the secondary layers of the liber-cells of very many plants, as of Flax (fig. 2 *b*, *c*), Coir (fig. 5 *a*, *b*), *Bœhmeria* (fig. 25 *b*, *c*), &c. All these spiral structures belong to the secondary deposits of the cells; they are mostly distinguishable from those previously described by being *thinner places* or *lines left bare*, instead of being *lines of deposit*.

We have observed a somewhat similar spiral streaking of the walls of *Hydrodictyon*, depending on slits in certain of the laminæ. Some of the genera of Oscillatoriaceæ, as *Ainactis* (Pl. 8. fig. 15 *b*) and *Schizosiphon* (fig. 13 *d*, *e*), also present a spiral-fibrous decomposition of their cellulose coats when old; and we have seen a spiral marking on the wall of *Cladophora*, as described by Mitscherlich. Agardh has stated that he detected a complicated spiral-fibrous structure in the cell-wall of Confervæ, extending, however, from one cell to another; and he regards this as a proof of the spiral structure of *primary* cell-membrane generally; and

says he has likewise detected an analogous spiral-fibrous structure in the primary cell-wall of the structures of the Phanerogamia. The delicate striation of the membranes of the Confervæ and slightly thickened liber- or parenchyma-cells of many Flowering plants form a desirable object of investigation for those accustomed to the delicate observation of the markings of the valves of the Diatomaceæ. The use of reagents, such as nitric acid and solution of potash, boiling, maceration, and other means must be employed for this purpose, controlled always by a careful observation of the structures in their natural state and in different stages of development. It is not impossible that all secondary deposits may prove, as Meyen assumed, to have a fibrous constitution, and true *membrane* to be confined to the primary walls. One set of layers, however, seems always to resist the endeavour to resolve them into fibrils, namely those of the horny and fleshy ALBUMEN of seeds.

As to the mode of the formation of spiral secondary deposits, little is certainly known. Crüger attributes them to spiral circulation of the secreting protoplasm over the cell-wall in the position of the future fibres; but this is a somewhat speculative notion. Others have asserted that they are formed by gradual collocation of visible granules; this is certainly an error. We have observed the gradual formation of the spiral band in the elater of *Marchantia*, where it is at first a faint spiral trace with indistinct edges; as it grows thicker, the edges become more and more defined; and it is produced originally in the exact position and pattern which it subsequently retains.

The actively moving spiral filaments or SPERMATOZOIDS of the Ferns, Mosses, Characeæ, &c. have nothing in common, except the spiral form, with the structures described in this article; they belong to the protoplasmic structures or *cell-contents*, as is also the case with the spirally-arranged green contents of SPIROGYRA; while this article refers exclusively to cellulose structures belonging to the *cell-wall*.

See also CELL, Vegetable; SECONDARY DEPOSITS; PITTED STRUCTURES; and TISSUES, Vegetable.

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SPIRILLI'NA, Ehr.—A doubtful genus of marine Infusoria, of the family Arcellina.

Char. Shell siliceous, porous, forming a flat spiral. *S. vivipara.* Shell microscopic, hyaline, smooth, containing numerous embryo shells. Found in America. (Ehrenberg, *Abh. Berl. Ak.* 1841, 402, 422.)

SPIRILLI'NA, Ehr., Rupt. Jones.—A genus of Rotaline Foraminifera, near *Pulvinulina.*

Char. Shell hyaline, consisting of a single elongated chamber, coiled into a flat close spiral; orifice simple, as wide as the tube.

Two recent British species, *S. perforata* (Pl. 24. fig. 5), and *margaritifera*; also some fossil (Jurassic and Tertiary).

BIBL. Williamson, *Rec. For.* 91; Carpenter, *For.* 180; Parker and Jones, *Ann. N. H.* 4. iv. 386; ix. 221.

SPIRIL'LUM, Ehr.—A genus of Schizomycetous Fungi.

Char. Consisting of a colourless, tortuous or cylindrical spiral filament.

These very minute organisms, found in infusions and decomposing liquids, are very interesting objects on account of the remarkable character of their corkscrew-like movements. They multiply by transverse division, separating into two portions while in motion. They are jointed or septate, but the joints are not always easy of detection. They are insoluble in boiling potash. Their structure is best examined when they are preserved in a dry state. They are apparently related to the Oscillatoriaceous Algæ, but are very different from *Spirulina*, with which they have been compared. *Spirillum bryozoon* consists of the spermatozoids of Mosses.

Like the other Schizomycetes, they produce decomposition in organic liquids. A species of *Spirochæta* is supposed to be the cause of relapsing fever, and occurs also in certain purulent discharges.

S. tenue (Pl. 7. fig. 17*f*). Filament slightly tortuous, indistinctly jointed; spiral of three or four turns; movement active; length 1-1000″; diam. 1-12,000″.

S. undula (Pl. 17. fig. 17*g*). Filament very tortuous, jointed; spiral of one or one and a half turns; length 1-1500″; diam.

1-120,000″. Perty describes a red and a black variety.

S. volutans (Pl. 7. fig. 23). Filaments very tortuous, distinctly jointed, with a cilium at each end; spiral of three, four, or more turns; length 1-1400″; diam. 1-14,000″.

S. plicatile (*Spirochæta plicatilis*, Ehr.) (Pl. 7. fig. 22). Filament very long, flexible; coils numerous; movement undulating; length 1-180″; diam. 1-12,000″.

Bibl. Ehr. *Inf.* 84; Dujard. *Inf.* 223; Rabenht. *Alg.* ii. 72.

SPIROCHÆTA, Ehr. — *S. plicatilis* = *Spirillum plicatile*.

SPIROCHO'NA, Stein. — A genus of Peritrichous Infusoria, family Vorticellina.

S. gemmipara (Pl. 32. fig. 35) is found upon the branchial plates of *Gammarus pulex*, where also its remarkable *Acineta*-form (fig. 36) occurs.

S. Scheutenii is met with upon the feathery setæ arising from the terminal joints of the post-abdominal legs of *Gammarus*.

S. tintinnabulum, on *Triton*-larvæ.

Bibl. Stein, *Inf.*; Clap. et Lachm. *Inf.* 132; Kent, *Inf.* 660.

SPIRODIS'CUS, Ehr.—Under the name *S. fulvus*, Ehrenberg places among the Infusoria, in the family Vibrionia, a brownish organism, consisting of a short discoidal or much-flattened helical spiral, 1-1200″ in diameter, and found in Siberia. It exhibited a slow movement. Ehrenberg's figure greatly resembles that in Pl. 40. fig. 34 (the upper two), without the cilia, and magnified 200 instead of 400 diameters. (Ehr. *Infus.* 86.)

SPIROGY'RA (*Zygnema*, Agardh in part) (fig. 668).—A genus of Zygnemaceæ (Confervoid Algæ), mostly very elegant, and all very interesting on account of their structure and modes of development. They are green filaments, floating unattached in standing fresh water. They consist of jointed tubes—that is, rows of cylindrical cells, sometimes of considerable size, in the interior of which the green colouring-matter is arranged in one or more spiral lines running round the walls, these spiral lines presenting bright points at intervals along their course (Pl. 9. figs. 17, 26, 27). The green lines consist of bands of protoplasm coloured by chlorophyll. The bright points are in some stages composed of globules of similar substance; but generally they are occupied by starch-granules imbedded in the protoplasm; smaller starch-granules also occur at certain stages throughout the green band. A remarkable lenticular nucleus is also present, suspended in the centre of the cell by threads of protoplasm running out to the primordial utricle lying against the cell-wall. Sometimes this nucleus is placed with its faces towards the side wall (*S. nitida*, Pl. 9. fig. 26); sometimes it appears to be placed with its faces looking up and down, as it presents the appearance of a narrow ellipse when seen sideways (*S. pellucida*, Pl. 9. fig. 27). The laminated structure of the cell-walls is also curious, but will be better understood after a sketch of the mode of development.

Fig. 668.

Spirogyra communis. Fragments of two filaments conjugating. Magnified 200 diameters.

The attractive appearance of the *Spirogyræ* and the easily observed phenomenon of conjugation have caused much attention to be paid to this genus; and many points of their history have been determined. The cells composing the filaments all multiply simultaneously when the plant is growing, each becoming twice its length and divided into two. It has been certainly observed by Braun and Pringsheim that the division is preceded by a division of the nucleus. From this interstitial mode of growth it is evident that the walls of the cells of plants actively vegetating must soon become composed of a number of layers belonging to distinct generations of cells. Thus, supposing we have an original cell *a*, this encloses its progeny, two cells a^2 & *b*; and when these divide again and come to enclose respectively a^3 & *c* and b^2 & *d*, the parent cell *a*, stretched to *four* times its original length, still encloses the whole. The laminæ belonging to the respective generations do not become very intimately blended; for by maceration we may cause the outer membranes to soften and dissolve, and set free the younger cells intact. The older membranes seem to have become thinner by stretching, or by solution, midway between their septa, since on maceration we may often see them give way in the middle, and the young cells slip out from them, leaving them as short hyaline tubes with a diaphragm in the middle. The ends of the cells of some species present a curious appearance, which might

be compared to the "punt" of a bottle, produced by a *circular fold* thrown in from the cross septum. It is attributed to the excessive growth of the membrane of the young cells, confined in space by the outer parent-membrane. The filaments of *Spirogyra* are consequently very instructive in reference to vegetative cell-formation. In some cases the half-dissolved parent-cell membranes form a delicate but well-defined gelatinous coat on the tube (Pl. 9. fig. 27 *s*).

The reproduction of this genus exhibits, besides the proper conjugation, other phenomena, the import of which is not yet fully determined. The conjugation itself has been observed by almost every microscopist. It consists essentially in the production of papillary elevations on the contiguous walls of the cells of two filaments lying side by side, the growth of these papillæ until they come into contact, and their coalescence so as to form a canal of communication between the two cells (fig. 668; Pl. 9. fig. 18). When this is accomplished, the contents of one of the cells (the contents of both having meanwhile lost their characteristic arrangement on the cell-walls) pass through the cross tube into the other cell, when the contents of both become blended and form an ellipitical free body (Pl. 9. fig. 18), which acquires cellulose integuments and becomes a *spore* or *zygospore*, lying free in the parent cell. This process is accompanied by the death of the parent filaments, conjugation often taking place in the majority of the cells: the spores are sometimes set free by decay of the parent cell-wall; but very often the latter remains undissolved until the germination of the spore (Pl. 9. fig. 19). A modification of this mode of conjugation (Pl. 3. fig. 24), occurs in some cases apparently as an abnormal process; for it has been observed (Braun) taking place in species which conjugate as above. It occurs in single filaments in which two contiguous cells produce papillæ at the adjoining ends, growing towards each other and coalescing, the contents of one of the cells thus passing into the next cell of the same filament. Braun calls this "chain-like" conjugation, in contradistinction to the "ladder-like" conjugation above described. As the two forms occur associated, Kützing's genus *Rhynchonema* and others founded upon this are of doubtful value.

The ripe spore or zygospore forms an elliptical body enclosed in three membranous coats, the outer of which is of delicate texture and separated by an interval from the next, which is brownish and of firm texture. The inmost coat or true spore-membrane, is again delicate. The spores appear to rest through the winter after they are formed, and to germinate in spring, in which process the middle coat of the spore splits at one end, longitudinally, opening by two valves to allow the inner to grow forth, which bursts through the outermost sac, in the form of a tube (Pl. 9. fig. 19) which soon acquires the characteristic appearance of the parent plants. The contents of the spore are brown and homogeneous during the stage of rest (fig. 21); in germination they become green again, and arrange themselves in the spiral bands (fig. 22), which become more distinct as the cell elongates.

Certain other occurrences take place in the cell-contents of the *Spirogyræ*, the relation of which to the reproduction is not so clear as the above. In filaments in an unhealthy condition, about to decay, such as are often seen when a collection of them is placed in a jar of water to keep for examination, it is not uncommon to see the green contents gradually lose their spiral arrangement and break up into a number of globular portions (Pl. 9. fig. 28); we have sometimes observed these rolling over slowly in the cell. In one case we have observed the contents converted into sixteen distinctly organized biciliated zoospores (Pl. 9. fig. 20), differing only from the ordinary zoospores of the Confervoids in the almost total absence of colour. They were somewhat crowded in the cell, and moved lazily about in it, the cilia vibrating. It is still more common to observe the contents of decayed filaments converted into encysted globules (Pl. 9. figs. 24, 25), which appear to be a kind of resting-form of the zoospores. These globules, which have a tough spinulose coat, have been observed by Pringsheim as produced from the contents both of ordinary cells, and abnormally? from the contents of a large spore (Pl. 9. fig. 23): the latter case might give colour to the idea that this was a sporange, had not its germination been observed. Pringsheim has further noticed that actively moving zoospores are produced from the small encysted bodies; perhaps these may fulfil an antheridial function. Carter has observed in the cells of *Spirogyra* the bodies constituting the genus *Pythium*, and apparently connected

with the zoospore-like bodies just described (see PYTHIUM).

The species of *Spirogyra* have been greatly multiplied by authors. The peculiar fold projecting from the septum appears to us to depend upon age and activity of growth; and the length of the joints depends greatly on the stage of growth, as they continually divide into two equal parts.

Spiral band single.

S. tenuissima. Vegetating filaments 1-3000″ in diam.; joints four or five times as long as broad; spiral band open; spore oblong-elliptical (Hassall, pl. 32. figs. 9, 10).

S. longata. Filaments about 1-1000″ in diam.; joints six or eight times as long; spiral lax, spores oblong-elliptical (Hass. pl. 31. fig. 394).

S. inflata (*S. gastroides*, Kütz.). Filaments 1-1680″ in diam.; joints four or five times as long; turns of spiral about five; fertile cells ventricose; spores oblong-elliptical (Hass. pl. 32. figs. 6, 7).

S. communis (fig. 668). Filaments 1-1440 to 1-2000″ in diam.; joints two or three times as long; turns of spiral four, broad; spores elliptical (Hass. pl. 28. figs. 5, 6).

S. quinina (Pl. 9. fig. 17). Filaments 1-600″ in diam.; joints once and a half or twice as long; turns of spiral broad and dense; spores elliptical (Hass. pl. 28. fig. 2). Varies in the length of the joints, which are sometimes twice to seven times as long.

Spiral bands two.

S. decimina. Filaments 1-720″ in diam.; joints two to four times as long; spiral bands lax, crossing so as to present the appearance of the letter X (Hass. pl. 23. figs. 3, 4).

S. elongata. Filaments 1-1320 to 1-1200″ in diam.; joints ten times as long; bands lax (Berkeley, *Gleanings*, 12, fig. 2).

Spiral bands numerous.

S. nitida (Pl. 9. fig. 26). Filaments 1-360″ in diam.; joints twice or three times as long; bands four, dense, closely veiled; spores elliptical (Hass. pl. 22. figs. 1, 2).

S. maxima. Filaments 1-200 to 1-300″ in diam.; joints equal, once and a half or twice as long; bands lax; spores globular (Hass. pls. 18, 19).

S. bellis. Filaments 1-400″; joints equal or twice as long; bands two or three, lax; spores rounded; var. *β*, spirals condensed (Hass. pl. 24).

S. pellucida (Pl. 9. fig. 27). Filaments 1-840″ in diam.; joints four or six times as long; bands lax and slender; fertile cells ventricose; spores globose (Hass. pl. 25).

S. rivularis. Filaments 1-2040″ in diam.; joints three or four times as long; spiral bands four, broad, dense (Hass. pl. 27).

S. curvatum (*Sirogonium stictitum* and *breviarticulatum*, Kütz.). Filaments 1-720″ in diam.; joints four or five times as long; bands three or four, slender; conjugation direct, without a cross branch, approaching *Mougeotia.* (Hass. pl. 26. figs. 1, 2.)

BIBL. Hassall, *Alg.* 135; Kützing, *Sp. Alg.* 437, *Tab. Phyc.* v.; Pringsh. *Flora*, xxxv. 465, *Ann. N. H.* 2. xi. 210; Braun, *Verjüngung*, *Ray Soc.*; Vaucher, *Conferves*, 37; Agardh, *Ann. Sc. Nat.* 2. vi. 197; Rabenh. *Alg.* iii. 232; Carter, *Ann. N. H.* 1880, vi. 207; Petit, *Spirog. of Paris*, 1881.

SPIROLI'NA, Lamk. (SPIRULINA, Ehr.). —Restricted. The long, narrow, crozier-like modifications of *Peneroplis* (*P.* (*Sp.*) *austriaca*, Pl. 23. fig. 12) come under this title. Fossil and recent.

BIBL. D'Orb. *For. Foss. Vien.* 137; Carpenter, *Phil. Tr.* 1859, 10; Parker, Jones, and Brady, *Ann. N. H.* 3. xv. 230.

SPIROLOCULI'NA, D'Orb. — A subgenus of *Miliola*, among the Porcellaneous Foraminifera.

Char. Shell regular, equilateral, compressed, oblong, oval, or elongated; *chambers* concentric on two opposing faces, in the same plane, not embracing, all apparent and with simple cavities; *orifice* single, situated alternately at the two ends of the longitudinal axis, simple or with a tooth, frequently prolonged into a tube.

Sp. planulata (Pl. 23. fig. 7). Many species, recent and fossil.

BIBL. D'Orb. *Ann. Sc. Nat.* vii. 298; Williamson, *Rec. For.* 82; Carpenter, *For.* 77; Parker, Jones, and Brady, *Ann. N. H.* 4. viii. 248.

SPIROM'ONAS, Perty.—A genus of Flagellate Infusoria.

Char. Body leaf-like, compressed, rounded at both ends, and rolled spirally; with one or two flagella.

S. volubilis = *Cyclidium distortum*, Duj. Kent describes other species. (Perty, *Lebensf.* 171; Kent, *Inf.* 297.)

SPIROPLEC'TA, Ehr. See TEXTULARIA.

SPIROR'BIS, Daudin, Lamk.—A genus of Annulata, order Setigera.

The elegant little milk-white flat spiral

shells of *S. nautiloides* (*communis*) (Pl. 36. fig. 29) are frequently met with upon *Fucus serratus*, &c. The animal has six pinnate branchial filaments and a pedunculate operculum.

SPIROS'TOMUM, Ehr. — A genus of Heterotrichous Infusoria, family Bursarina.

Char. Body ciliated all over, oblong or cylindrical and elongated, or flat; mouth spiral, with neither teeth nor a tremulous lamina; anus posterior; freshwater.

S. ambiguum (Pl. 31. figs. 77. 78). Body cylindrical and elongated, colourless, obtuse in front, truncate behind, prolonged anteriorly beyond and above the mouth; length 1-12″.

S. teres. Body linear-fusiform; length 1-60″.

Bibl. Ehr. *Inf.* 332; Dujard. *Inf.* 514; Clap. et Lach. *Inf.* 231.

SPIROTÆ'NIA, Bréb. — A genus of Desmidiaceæ.

Char. Cells single, elongated, cylindrical or fusiform, straight, entire, not constricted; endochrome spiral.

Division oblique. In one species the endochrome is spiral at first, subsequently becoming uniform.

S. condensata (Pl. 14. fig. 59). Endochrome forming a single broad band; length 1-208″; common.

S. obscura. Endochrome at first forming several spiral threads, afterwards uniform; length 1-240″.

Bibl. Ralfs, *Desmid.* 178; Archer, *Qu. Mic. Jn.* 1867, 186; Rabenhorst, *Alg.* iii. 145.

SPIRULI'NA, Link.—A genus of Oscillatoriaceæ (Confervoid Algæ), consisting of minute spirally coiled geeen filaments immersed in a colourless gelatinous matrix, and having an oscillating motion; forming extensive strata in lakes, brackish water, &c. The intimate structure and development of these curious organisms are not yet well understood; they are supposed to increase by the filaments breaking across: in some the filament appears continuous; in others it has striæ, like the *Oscillatoriæ*, appearing beaded when badly defined.

S. Jenneri (Pl. 7. fig. 16). Filaments with striæ, 1-6000″ in diameter, usually of eight or ten coils, forming a thin æruginous stratum.

S. oscillarioides (Pl. 7. fig. 15). Filaments not striated; coils 1-7200″ in diam.; lax. Among *Oscillatoriæ* in stagnant pools.

Bibl. Kützing, *Sp. Alg.* 236; Hassall, *Alg.* 277, pl. 75; Harvey, *Mar. Alg.* 229, pl. 27; *Phyc. Br.* pl. 105; Ralfs, *Ann. N.H.* xvi. 308, 2. viii. 205; Cohn, *Nova Acta*, xxiv.; Rabenht. *Alg.* ii. 90.

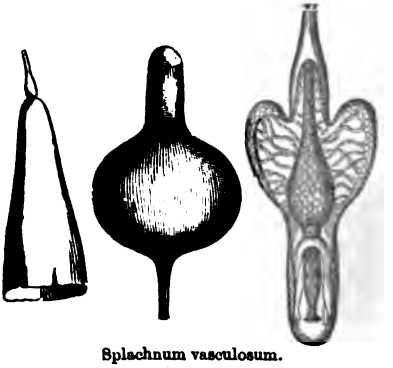
SPLACHNA'CEÆ.—A family of Funarioideæ (Acrocarpous operculated Mosses), of broad and densely tufted habit, mostly found upon dung, with a very much branched, loosely-leaved stem (fig. 669). Inflorescence hermaphrodite, dicœcious, rarely moncœcious. Antheridial flower a capituliform, terminal bud. Antheridia large, club-shaped, rather

Fig. 669. Fig. 670.

Splachnum vasculosum.

Fig. 669. Nat. size.
Fig. 670. Ripe capsule open, dried, and the apophysis shrivelled. Magnified 20 diameters.

Fig. 671. Fig. 672. Fig. 673.



Splachnum vasculosum.

Fig. 671. Calyptra. Magnified 20 diameters.
Fig. 672. Young capsule and apophysis. Magnified 20 diameters.
Fig. 673. Vertical section of an unopened capsule with its spongy apophysis. Magnified 20 diameters.

curved. Archegonia narrow, long-apiculate. Peristome, if present, of regularly

lanceolate, neither obtuse nor trabeculate, twin, rufescent, rather fleshy teeth. Columella ordinarily projecting (fig. 670). Capsule on an apophysis (fig. 673), mostly furnished with stomates.

British Genera.

Œdipodium. Calyptra soft, longish-narrow, split almost to the summit, obtuse, somewhat lacerated at the base. Capsule subglobose, loosely reticulated, soft, with a very long collum arising from a gradually thickened fruit-stalk, the mouth naked. Columella dilated at the apex. Inflorescence monœcious.

Tetraplodon. Calyptra smallish, hood-shaped, split to the middle, operculate, delicate. Capsule apophysate, oval-cylindrical. Apophysis obconical, obovate, or subovate. Columella scarcely dilated at the apex. Peristome of sixteen double teeth in fours, lanceolate, formed of two rows of cells, connate in pairs at the base, reflexed when dry, erect and incurved when moist, much shorter than the capsule. Antheridial flower sessile in the axil of a leaf, or terminal on a little special branch, in a capituliform bud.

Tayloria. Calyptra inflatedly conical, erect, split at one side, constricted at the base, lacerated around the margin. Peristome arising below the orifice of the capsule, of sixteen or thirty-two teeth; teeth single, approximated in pairs or coherent, often very long; when moist incurved and involuted, when dry (in the ripe capsule) reflexed, appressed to the capsule or tortuously bent down; very hygroscopic. Inflorescence monœcious. Columella mostly free, exserted from the ripe capsule, flattish-apiculate.

Dissodon. Calyptra inflatedly conical, erect, slit at one side, constricted at the base and torn or erose. Peristome arising at the orifice of the capsule. Teeth thirty-two, connate, in eight bigeminate or sixteen geminate teeth, lanceolate, smooth, transversely articulate, connivent into a depressed cone when moist, subincurved when dry. Inflorescence perfect or monœcious. Columella included or exserted, flattish.

Splachnum. Calyptra conical, rather small, entire or slit here and there at the base. Peristome of sixteen teeth, composed of a double row of cells, lanceolate, largish, yellowish, approximated in pairs and to some extent conglutinated, when dry reflexed and appressed to the capsule, when moist erect and incurved at the apex. Inflorescence dicœcious, rarely monœcious. Columella ordinarily emerging, capitate.

SPLACHNUM, Linn. — A genus of Splachnaceæ (see above). *S. ampullaceum* is not uncommon on the dung of animals on bogs, is a very handsome moss, with purple or red capsules. *S. vasculosum* (figs. 669–673) is less common, occurring only in high mountain districts.

SPLEEN.—This organ appears to occur exclusively in the Vertebrata, but is not found in the Leptocardia and Myxinoids. The spleen is covered externally by the

Fig. 674. Fig. 675. Fig. 676.

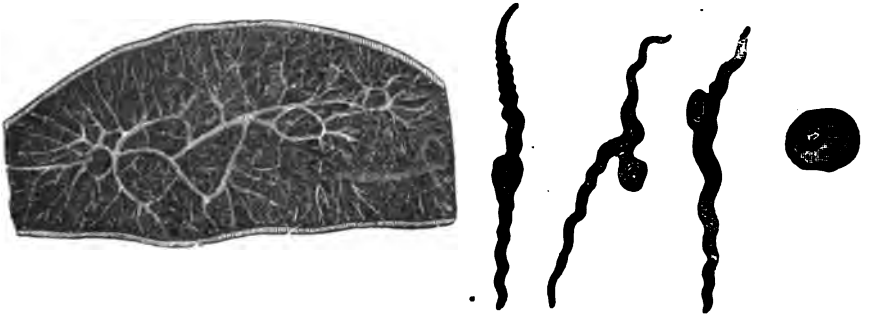


Fig. 674. Natural size. Portion from the middle of the spleen of an ox, washed; showing the bands and their arrangement.

Fig. 675. Peculiar fibres from the pulp of the human spleen, belonging to the microscopic trabeculæ. Magnified 350 diameters.

Fig. 676. One of the same enclosed in a cell. Magnified 350 diameters.

peritoneum, except at the hilus, where the vessels are connected with it.

Beneath the peritoneal tunic is a thin, semitransparent, firm, fibrous coat, which at the hilus accompanies the vessels, and forms sheaths around them.

The spleen is traversed by fibrous bands or trabeculæ (fig. 674), which arise from the inner surface of the fibrous coat and from the outer surface of the vascular sheaths, and, being connected with each other, form a number of irregular meshes or areolæ, in which are situated the splenic corpuscles and the spleen-pulp. In reptiles they form stellate expansions, their connective tissue becoming infiltrated with lymph-corpuscles; and the connective tissue in this modified form occupies all the interspaces of the proper parenchyma of the organ.

The fibrous coat and the trabeculæ consist of ordinary connective tissue, with mostly parallel fibres, traversed by networks of fine elastic fibres, which become continuous with the coats of the veins. In certain animals, as the dog, cat, pig, &c., the fibrous coats and trabeculæ contain also unstriped muscular fibres. These do not occur in man, unless they are represented in the microscopic trabeculæ by peculiar wavy fibres, about 1-500″ in length, with lateral or stalked nuclei (fig. 675). Some of these are found enclosed in cells (fig. 676), from which they become liberated by the action of water.

The splenic or Malpighian corpuscles (fig. 677) are white rounded bodies, imbedded in the spleen-pulp, and attached to the smallest arteries. They vary in size from 1-120 to 1-36″, and cannot always be detected. They are either placed upon the sides of the arterial branch, or situated in the angles of their bifurcation.

The splenic corpuscles consist of an enveloping membrane (fig. 678 *a*) composed of connective tissue with fine reticular elastic fibres, and derived from the arterial sheath. They are traversed by capillaries and filled with a tenacious grey parenchyma. The parenchyma consists of cells 1-3000′′ in diameter, containing one or two nuclei, and free nuclei (fig. 104, p. 138). Sometimes the cells contain globules of fat or blood-corpuscles; and occasionally free blood-corpuscles are met with. When the splenic corpuscles undergo amyloid degeneration, they produce the so-called sago-spleen.

The splenic pulp forms a soft reddish

Fig. 677.

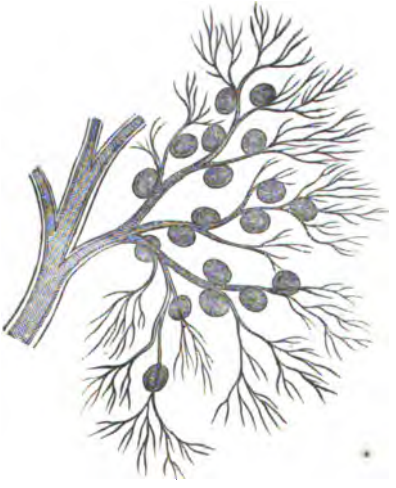


Fig. 678.

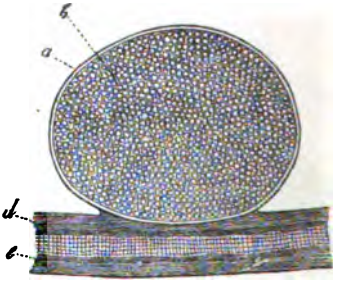


Fig. 677. Portion of a small artery from the spleen of a dog, with one of the branches covered with Malpighian bodies. Magnified 10 diameters.

Fig. 678. Malpighian corpuscle from the spleen of an ox. *a*, wall of the corpuscle; *b*, contents; *e*, wall of the artery upon which it is situated; *d*, its sheath. Magnified 150 diameters.

mass, and consists of three elements—microscopic trabeculæ, fibres, or bands, parenchyma-cells, and the smaller blood-vessels—or of cells and an intercellular substance. The trabeculæ agree in structure with the larger ones. The fibres or bands are the terminations of the sheaths of the vessels; they are indistinctly fibrous, and free from elastic tissue. The parenchyma-cells resemble those in the splenic corpuscles. Blood-corpuscles are found enclosed in cells, from one to twenty in each, or surrounded by a transparent substance, their contents exhibiting various changes in colour and consistence. The arteries terminate in elegant tufts or penicilli, becoming continuous with a meshwork of capillaries.

The blood-corpuscles from the blood of the splenic vein frequently contain crystals of hæmatoidine.

In the examination of the spleen, the trabeculæ are best seen after washing away the pulp with water, the splenic corpuscles by tearing the spleen or boiling it, either in the pig or ox. The cells containing blood-corpuscles must be searched for in the pulp unacted upon by water. The muscular fibres are most evident in the smaller trabeculæ, especially after treatment with dilute nitric acid (one part to five parts of water).

Bibl. Kölliker, *Mik. An.* ii. and *Todd's Cycl. An.*, art. *Spleen*; Gray, *A. Cooper's Prize Essay*; Saunders, *Goodsir's Ann. of An.* 1851, i.; Huxley, *Qu. Mic. Jn.* ii. 1854; Frey, *Mikros.*; Müller, *Stricker's Hist.* and the *Bibl.* therein.

SPOLVERI'NA, Mass.—A genus of Micro-lichens, parasitic on the thallus and prothallus of various crustaceous lichens.

Char. Spores 1–2, large, globose-ovoid, simple, colourless, or yellowish. (Lindsay, *Qu. Mic. Jn.* 1869, 344.)

SPONDYLOCLA'DIUM.—A genus of Dematiei (Hyphomycetous Fungi), analogous to *Arthrobotryum*, characterized by the erect filaments, with whorled multiseptate spores (Pl. 27. fig. 15). (Mart., *Fl. erl.* 354; Link, *Spec.* 79; Hoffmann, *Fl. germ.* ii. pl. 13.)

SPONDYLOM'ORUM, Ehr.—A genus of Volvocineæ.

S. quaternarium. Cœnobium globose, composed of 8-12-16 cuneate green cells, each with a long cilium, and a dorsal red eye-spot, enclosed in a colourless gelatinous envelope (Pl. 3. fig. 23). In ditches. (Perty, *Lebensf.* 177; Rabenht. *Alg.* iii. 98.)

SPONGASTERIS'CUS, Hckl.—A genus of Radio-flagellate Infusoria, with a siliceous perforated carapace. 2 species; marine. (Kent, *Inf.* 229.)

SPON'GIDA or PORIF'ERA.—A Class of Protozoa.

Char. Form variable; fixed by a kind of root at the base, or incrusting; consisting of a soft gelatinous sarcodic mass, mostly supported by an internal skeleton, composed of reticularly anastomosing horny fibres, in or among which are usually imbedded siliceous or calcareous spicula; or sometimes the spicula alone form the skeleton.

The horny fibres forming the skeleton of sponges, which may be well seen in any common sponge, are cylindrical, and variously united, so as to form a coarse network with roundish or angular microscopic meshes. In addition to these generally diffused meshes or intervals, large (to the naked eye) rounded apertures or oscula are scattered over the surface of most sponges, leading into sinuous canals permeating their substance in every direction; and between these are other smaller apertures, just visible to the naked eye, also the orifices of canals, which traverse the substance and communicate with the oscular canals.

In the living sponge, this skeleton is covered with a glairy or gelatinous, colourless, amorphous substance, resembling that of which *Amœbæ* are composed; the proportion being variable in the different genera. This substance appears to be composed of minute masses, those on the surfaces being furnished with a long and slender flagellum, or forming collared monads; and during life, by means of these, water entering by the smaller apertures, and reaching the oscular channels, is expelled from the oscula in currents, which may be rendered visible by sprinkling a little finely powdered charcoal over them. Hence Clark and Kent refer the Sponges to the Choano-flagellate order of the Infusoria.

The fibres of the common Sponges appear to be solid under the microscope; and when treated with sulphuric acid, they are seen to consist of two parts, an outer tubular portion, which is contracted in length by the acid, and an inner cylindrical thread, which usually becomes elegantly wavy or spiral, frequently protruding from the cavity of the outer portion in broken fibres, and resembling Pl. 28. fig. 22.

The spicula are of various forms (Pl. 45, lettered figures), and either scattered through

the substance or arranged in bundles forming spurious fibres; sometimes projecting more or less from the surface (Pl. 45. fig. 8). In some sponges they are absent, and in one genus they are replaced by gravel. The calcareous spicula exert a much more powerful action upon polarized light than the siliceous spicula.

In some sponges, an external membrane is present; and this has been observed to exhibit a reticular or cellular appearance, from the presence of fine reticular fibres.

Sponges are mostly marine, rarely freshwater. In the natural state they often possess lively colours, which appear in some instances to arise from the presence of granules of colouring matter, probably chlorophyll, in others from iridescence. They usually grow in groups upon rocks, shells, zoophytes, sea-weeds, &c.

Sponges appear to be propagated in four ways:—by gemmation, from the interior of the canals; by the formation of ciliated gemmules (swarm-spores); by the formation of true sexual ova; and by the production of bodies analogous to "winter-ova."

The ciliated gemmules, which are not of general occurrence, are yellowish, oval, narrowed at one end, and covered, except at this part, by vibratile cilia. They are mostly formed in spring, and after swimming about for a time, become fixed to some suitable spot and undergo development.

Of the other reproductive bodies, one kind consists of roundish or ovate masses containing spicula and resembling the parent in structure, either lying loose in its substance, or adherent to the horny fibres, and escaping at its death and solution, to acquire maturity.

The "winter-ova" are round or ovoid seed-like bodies, with a funnel-shaped depression on the surface communicating with the interior. At first these lie in a cavity formed by condensed surrounding substance; subsequently a membrane presenting a hexagonal reticular structure is formed around them, upon which a crust of spicula is afterwards deposited. When expelled from the body of the parent, they are motionless; they then swell up, burst, and the minute locomotive germs escape. These exhibit *Amœba*-like processes, and take on an independent life.

The true ova are oval, and scattered through the general substance; they have a distinct outer membrane, with a germinal vesicle and spot. The spermatozoa have an oval body and a filament; they occur in minute cells, also diffused through the substance. The germs are ciliated.

Sponges are probably nourished by enclosing Algæ &c. in their substance in the same manner as *Amœbæ*. This has been seen to take place in the young animals developed from the winter-ova.

According to the skeleton, the sponges are divided into three Orders: *Myxospongiæ*, in which it is absent (Halisarca); *Fibrospongiæ*, in which it is horny or siliceous; and *Calcispongiæ*, in which it is calcareous.

Thread-cells have been found in the genus *Reniera*; and Eimer states that he has even distinguished in some siliceous forms something like connective tissue and fusiform muscular fibres.

BIBL. Johnston, *Br. Sponges*; Bowerbank, *Br. Spong.*, *Ray Soc.* 1866; Huxley, *Comp. Anat.*; James-Clark, *Amer. Jn. of Sci.* 1871; Gray, *Pr. Roy. Soc.* 1867; Lieberkühn, *Müller's Archiv*, 1856, *Ann. N. H.* 1868, ii. 236; Thomson, *Phil. Tr.* 1869, and *Deep-sea Dredging*; Ellers, *Sieb. und Köll. Zeit.* 1871, xxii. 540; Eimer, *Schultze's Arch.* 1872; Leidy, *Amer. Nat.* 1870; Agassiz, *Bull. Harvard Coll.* 1869; Miklucho-Maklay, *Mém. Acad. Pétersbourg*, 1870; Schmidt, *Spongienfauna Atlan. Geb.* 1870; *Spong. Küste Algier*, *Spong. d. Adriat. Meer.*; Carter, *Ann. N. H.* 1878, ii. 157; *ib.* 1879, iii. 284, 343; *ib.* 1879, iv. 374; Gosse, *Mar. Zool.* i.; Haeckel, *Kalkschwämme*, 1873; Vosmaer, *Bronn, Klass. &c.*, 1882; Kent, *Inf.* 143.

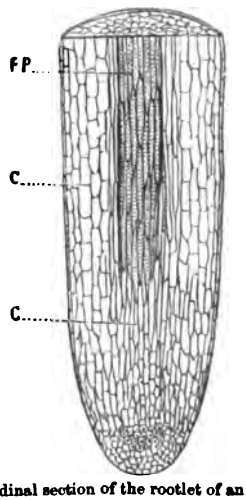
SPONGIL'LA, Lam.—A genus of freshwater sponges. Two British species, *S. fluviatilis* and *S. lacustris*.

Found attached to stones, old woodwork, &c. in still or slowly running waters; green or grey. See SPONGIDA.

SPONGIOLES.—Many works on vegetable physiology still retain the old error that the extremities of roots are devoid of epidermis, and that the tissue then presents an open spongy character, whence the name of *spongioles* applied to the absorbing apices of roots. So far is this from being a correct account of the conditions, that, in reality, not only is the surface completely invested with a continuous epidermis, but the growing point and principal absorbing surface is found a little above the absolute extremity, which is pushed forward by interstitial growth (fig. 679). See ROOTS.

SPONGOCYC'LIA, Hckl.—A genus of Radio-flagellate Infusoria. Several species; marine. (Kent, *Inf.* 228.)

Fig. 679.



Longitudinal section of the rootlet of an Orchis.

C, C, Cellular tissue (cambium) in which development is still going on. *F P*, Fibro-vascular bundles gradually becoming organized from above downwards.

Magnified 500 diameters.

SPONGOM'ONAS, Stein.—A genus of Flagellate Infusoria. Ovate or rounded; flagella two, equal; immersed in a gelatinous envelope. Four species; freshwater. (Kent, *Inf.* 286.)

SPORAN'GIUM and SPOR'OCARP.—The term sporangium is applied to the structure immediately enclosing the spores of the Cryptogamia. The different forms and conditions are described under the classes of Flowerless plants. Abortive sporangia in Ferns, sometimes borne on the pedicel of the true sporangia, are called sporangiastra. Sporocarp or spore-fruit is the name given to the capsules or similar organs which contain the sporanges of the Marsileaceæ (see PILULARIA).

SPORENDONE'MA, Desm.—A supposed genus of Sepedoniei (more properly belonging to Saprolegneæ). It is a very common occurrence in autumn to find the house-fly, dead, adhering to walls, window-panes, &c., firmly fixed by its proboscis, and with its legs spread out, thus differing from dead flies in general, which have the legs contracted. In about twenty-four hours after death, a kind of fleshy substance of a white colour, is found in the form of a ring projecting between each of the rings, of the abdomen; and in a day or two after, the whole will be found dried, and the surface of the wall or glass lightly covered in a semicircle, at about 1-2 to 1″ from the fly's abdomen, with a cloud of whitish powder. The whitish fleshy substance is found on examination to consist of a vast number of short erect filaments growing out from the interior of the fly's body, between the rings; these filaments contain large oil-globules, often arranged in a row; and their having been mistaken for spores gave origin to the name *Sporendonema* applied to this fungus. Cohn has described its growth somewhat minutely, and changed the generic name to *Empusa*, or rather *Empusina*, the first of these names being already occupied. He correctly states that the vertical filaments terminate in the abdomen in a continuous, often branched tube, and consist therefore of a single tubular cell. The upper free end, however, becomes cut off by a septum; and the terminal cell acquires a campanulate form and a darkish colour; when ripe, it is thrown off with elasticity; and a number of these form the white cloud above mentioned. Cohn endeavoured in vain to make them germinate; and nothing like them was found in the cavity of the abdomen of numerous flies in which the filaments were traced in their earlier stages. From our own observations, we rather incline to regard them as *peridioles* or spore-cases, comparable perhaps to that of *Pilobolus*; or they may be stylospores, like some of those of the Uredinei, which after a stage of rest produce an intermediate mycelial structure, and then give birth to the ripe spores.

The most remarkable point about this fly-fungus (to which, however, Cohn does not allude) is the circumstance that, when the body of the fly with the rings of fungi freshly developed is placed in water, ACHLYA *prolifera* is almost always, if not always, produced, and apparently from the filaments which in the air produce the bell-shaped deciduous body above described. We find the *Achlya* with its ciliated zoospores, and later with its globular sporanges filled with spores, apparently representing an aquatic form of the *Sporendonema* or *Empusina*. Cienkowski has recently confirmed the view that *Achlya* is an aquatic form of the present plant, but Braun denies this; he states that he has found a second species of *Empusina* on the common gnat (*Culex pipiens*).

Sporendonema Casei, Desm., is referable to TORULA.

BIBL. Berk. *Br. Fl.* ii. pt. 2. 350; Fries, *Syst. Myc.* iii. p. 435, *Sum. Veg.* 594; Varley, *Tr. Mic. Soc.* iii.; Cohn, *Nova Acta*, xxv. 299; Berk. and Broome, *Ann. N. H.* 2. v. 400; Cienkowski, *Bot. Zeit.* xiii. 801; Braun, *Alg. Unicell.* 105.

SPORES, SPORULES, SPORIDIA, SPORIDIOLA, MICROSPORES, MACROSPORES, &c.—A number of nearly connected terms which are applied to the various organs which either really or apparently represent, in the Flowerless Plants, the *seeds* of the Flowering classes. The names have been mostly applied with the view of marking slight distinctions between organs supposed to be homologous. Of those placed at the head of this article, the first only should be retained, the second being merely a useless diminutive of it, and the third and fourth being superseded by the more definite nomenclature now applied to the reproductive bodies of the Cryptogamia.

It may be desirable perhaps here, if merely for the sake of explaining the exact meaning of words constantly used in this work, to pass in review the various structures comprehended under the general name of Spore.

The definition of the word spore itself, as commonly used, may be stated thus:—a reproductive body, thrown off by a Flowerless plant to reproduce its kind, and containing no embryo at the moment when cast off by the parent. It is evident from this how lax is its application.

The highest of the Flowerless plants, the Marsileaceæ and the Lycopodiaceæ, produce two kinds of spore—one destined to produce spermatozoids, the other archegonia and ultimately embryos growing up into new plants. These are sometimes distinguished as *pollen-spores* and *ovule-spores* or *oospores*; the latter are large sacs with complicated outer membranes, the former simple cells with a double coat, like pollen-grains (see PILULARIA, ISOËTES, and LYCOPODIACEÆ).

The Ferns and the Equisetaceæ produce only one kind of spore, a simple cell with a double coat, the outer of which is generally elegantly marked in the former (figs. 232–236, p. 321), and split up into elastic filaments or elaters in the latter (fig. 205, p. 300). In germinating, this spore produces a kind of thallus, the prothallium (figs. 236–239, p. 321), on which antheridia and archegonia ultimately appear, and an embryo is formed, fertilized, and developed (see FERNS and EQUISETACEÆ).

In the above cases the spores are always formed in sporanges of various kinds, developed directly from the axis or the leaves by a process of vegetative growth.

In the Mosses and Liverworts the spores are mostly of one kind, consisting of a cell with a single or (generally) double coat, like a pollen-grain. The spores, unlike those above-mentioned, are formed in sporanges which are the product of fertilized archegonia, and more resemble the *fruits* of Flowering plants. The spores of Mosses germinate by emitting the inner coat as a Confervoid filament (fig. 680), which usually branches and gives origin to numerous stem-buds. The spores of the Liverworts exhibit many modifications in the first stages of germination, as illustrated by the accompanying figures (figs. 682–684); the Marchantiæ and other frondose kinds grow at once into thalloid fronds (see MOSSES and HEPATICÆ).

Fig. 680.

Spores of a moss germinating. Magn. 100 diams.

The systematic position of the Characeæ is perhaps still an open question; but there can be little doubt of the analogies between these red productive bodies and those of the other Cryptogamia. There is no sporange here, nor apparently any archegonia. The *globule* (figs. 121 & 122, p. 162) produces antheridia giving birth to spermatozoids. The *nucule* (fig. 120, p. 161) appears to be a spore (see CHARACEÆ).

In the Lichens, only one kind of organ has been termed a *spore*, namely the reproductive cells formed in the theceæ (Pl. 37. figs. 6 & 12), which are known to reproduce the plant when thrown off by the parent. Two other kinds of body connected with the reproduction occur; these, the *gonidia* (Pl. 37. figs. 2, 3) and the *spermatia* (see LICHENS), have fortunately obtained and preserved distinctive appellations. The spores are simple cells or septate tubes, with a double membrane.

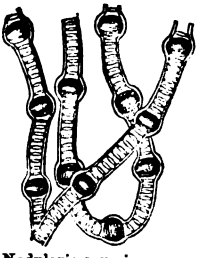
In the Algæ much confusion still exists, not only between different kinds of spore, but even between spores and sporanges; and this is not easily cleared away, since in certain cases the organs appear really capable of serving as one or the other, according to circumstances; the true spores are

always simple cells with a double or triple coat.

In the Florideæ, the characters of the structures seem pretty clear; we find spores (p. 327), TETRASPORES (figs. 248–250), which appear to represent the gonidia of the Lichens, and spermatozoids (see FLORIDEÆ). Among the olive-coloured sea-weeds (Fucoids), the FUCACEÆ and DICTYOTACEÆ produce spores and spermatozoids; but in the majority of the families, only a totally different mode of reproduction is known. The plants produce ovate sacs, commonly called spores, and chambered filaments; from both are discharged actively moving ciliated cells, corresponding exactly to the ZOOSPORES of the Confervoids. Thuret regards the *oosporanges* and *trichosporanges* (fig. 458, p. 501), as he called these sacs and filaments respectively, as merely different forms of one kind of structure. But it seems possible that true *spores* may be discovered, even indeed that the oosporanges may be parent cells sometimes of zoospores and sometimes of spores.

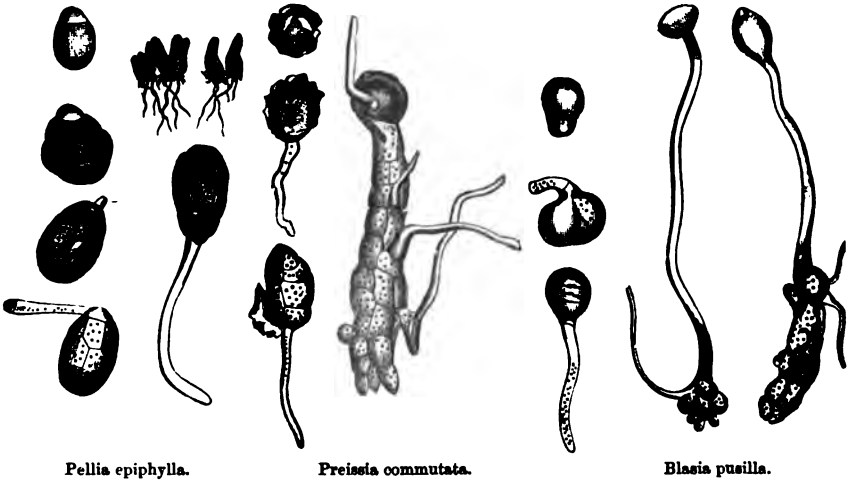
In the Confervoids we find true spores in very many cases, produced generally after some process of fertilization or of CONJUGATION, in special cells (fig. 668, and Pl. 9. figs. 16 & 18; Pl. 10. figs. 1–5). But the "spores" thus produced, while they sometimes germinate into new filaments, also sometimes produce numerous bodies of different kinds, connected in some way with reproduction; this is the case in SPIROGYRA (Pl. 9. fig. 23), perhaps also in CLOSTERIUM and other instances. Besides the *spores* proper, we have also in this family, ZOOSPORES —the actively moving ciliated bodies which are regarded as *gonidia* and are further di-

Fig. 681.



Nodularia spumigera.
Filaments with sporangial cells containing quaternate spores.
Magn. 200 diams.

Fig. 682. Fig. 683. Fig. 684.



Pellia epiphylla. Preissia commutata. Blasia pusilla.
Spores of Hepaticæ germinating. Magnified 200 diameters.

vided into *macrogonidia* and *microgonidia* (HYDRODICTYON), the latter of which may perhaps have the function of spermatozoids (see SPHÆROPLEA and VAUCHERIA).

In the Fungi the greatest confusion exists in the nomenclature. The Agarics and their congeners produce free naked cells at the tips of short filaments, whence they ultimately fall off, to reproduce the plant; these are called *spores* or *sporules*, or distinctively BASIDIOSPORES (figs. 53–55, p. 92). There is no essential difference between them and the spores produced by the Hyphomycetes, either singly or in rows or capitula (Bo-

TRYTIS, figs. 77, 78, p. 116; figs. 685, 686; and Pl. 26. figs. 5, 6, 15, 16) at the ends of

Fig. 685.

Fig. 686.

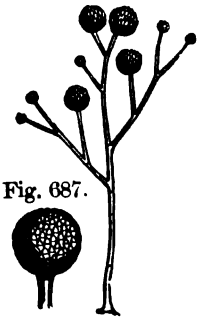


Fig. 687.

Fig. 685. Mystrosporium Stemphylium, Corda (Stemphylium, Fries). Magn. 200 diams.
Fig. 686. Stachyobotrys atra. Fertile filament with heads of acrogenous spores. Magn. 200 diams.
Fig. 687. A head of spores. Magn. 500 diams.

erect filaments; these again appear to pass almost insensibly into the *conidia* or reproductive cells produced by the breaking-up of the mycelium, either wholly or in part, into free cells capable of continuing the growth (TORULA, Pl. 26. fig. 7, and OIDIUM, fig. 8): on the other hand, the *spermatia* (figs. 2, 3, 4), such as occur in some of the Coniomycetous forms of the Pyrenomycetous and Discomycetous Fungi, are closely related, as far as structure goes, to the conidia of *Torula* &c. and the spores of the Hyphomycetes; while the *stylospores* of the UREDINEI and TREMELLINI produce bodies resembling them, and still more like the basidiospores of the Agaricini. The stylospores, another free form of spore, may be regarded probably as compound organs, formed of a row of cells contained in a persistent parent cell: it is surmised that they are merely metamorphosed asci (see SPHÆRIA and STILBOSPORA, Pl. 26. figs. 25–28); yet their mode of occurrence would lead to the idea that they are a distinct kind of organ. Lastly, we have the *ascospores* or *thecaspores* (fig. 42, p. 78), closely resembling those of the Lichens, consisting of free cells with a double coat, developed free in the cavity of a parent cell or sac. In the *British Flora* the terms *sporule* and *sporidium* are used synonymously in the sense of *spore*, and are applied to basidiospores, ascospores, stylospores, and to the bodies (found in *Cytispora*, *Tubercularia*, &c.) called by Tulasne spermatia. The term *sporidiola* is applied apparently to nuclei or granular masses occurring in the cavities of spores, or to the separate portions of contents of imperfectly septate stylospores.

The sporangia of Diatomaceæ are sometimes called Auxospores.

With regard to the homologies of the above structures, the *spermatia* are supposed to represent spermatozoids; the *conidia* are regarded as corresponding to gonidia of Lichens; the stylospores are also connected with these through the medium of the tetraspores of the Floridese.

In conclusion, a reference may be made to descriptions and figures like those given (figs. 688, 689) of *free* spores resting on the matrix and among the filaments. Such characters are totally out of date in the present state of science, and simply serve as indices of points requiring further investigation.

Fig. 688.

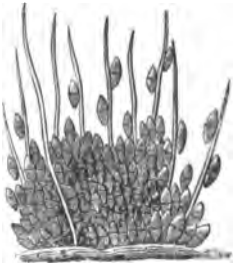


Fig. 689.

Fig. 688. Leptotrichum glaucum. Free spores among the filaments of the matrix. Magn. 200 diameters.

Fig. 689. Fusarium herbarum. Free spores resting on the matrix. Magn. 200 diameters.

BIBL. See the heads of the classes of Cryptogamic Plants.

SPORIDES'MIUM.—A genus of Torulacei (Coniomycetous Fungi), growing upon bark, wood, &c. (Pl. 27. fig. 12).

Fig. 690.

Sporidesmium paradoxum. Spores sessile on the matrix. Magn. 200 diams.

The character of the spores seems to vary in different species; sometimes they are simply septate, sometimes cellular (fig. 690).

See TORULACEI.

SPOROCHIS'MA, Berk. and Br.—A

genus of Torulacei (Coniomycetous Fungi), containing one species, *S. mirabile*, forming a black velvety stratum on rotten beech wood. See TORULACEI.

SPOROCHNA'CEÆ.—A family of Fucoideæ. Olive-coloured, inarticulate seaweeds, whose unilocular and septate sporanges are attached to external jointed filaments, which are either free or compacted together into knob-like or warty masses.

Synopsis of British Genera.

* *Sporanges attached to pencilled filaments issuing from the branches* (Arthrocladieæ).

Desmarestia. Frond solid or flat, dichotomously branched.

Arthrocladia. Frond traversed by a jointed tube, filiform, nodose.

Stilophora. Frond filiform, tubular or solid, branched; sporanges arising from necklace-shaped filaments collected in wart-like groups upon the frond.

** *Sporanges produced in knob-like receptacles composed of whorled filaments compacted together* (Sporochneæ).

Sporochnus. Receptacles lateral, on short peduncles.

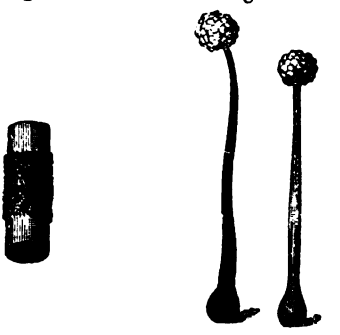
Carpomitra. Receptacles terminal, at the tips of the branches.

SPOROCH'NUS, Ag.—A genus of Sporochnaceæ (Fucoid Algæ), containing one British species, *S. pedunculatus* (Pl. 4. fig. 1), having a filiform, solid, cellular main axis (containing a central cord of dense tissue), bearing long slender branches arranged in a somewhat pinnate manner and clothed at intervals with elliptical fertile ramules, consisting of an axis densely covered with whorled horizontal branching filaments bearing ovoid *sporanges*, and terminating in a deciduous pencil of byssoid filaments. Main stem 6 to 8″ long, olive-brown, changing to yellow-green on exposure.

BIBL. Harvey, *Mar. Alg.* 25, pl. 5 A; Greville, *Alg. Br.* pl. 6; Thuret, *Ann. Sc. Nat.* 3. xiv. 238.

SPOROC'YBE, Fries.—A genus of Dematiei (Hyphomycetous Fungi), growing on dead sticks, decaying stems, &c., forming usually a blackish stratum. Several British species are recorded. They have a rigid, septate, simple or branched peduncle, ending with a capitate head clothed with spores (figs. 691, 692). This genus is synonymous with *Periconia*, Corda. *Periconia*, Tode, is an obscure form.

Fig. 691. Fig. 692.



Sporocybe bulbosa.

Fig. 691. Stratum upon a stick. Nat. size.
Fig. 692. Two fertile peduncles, crowned with heads of spores. Magnified 100 diameters.

BIBL. Berk. *Br. Flor.* ii. pt. 2. 333; *Ann. N. H.* vi. 433, pl. 13; Fries, *Sum. Veget.* 467; *Syst. Mycol.* iii. 340.

SPOROT'RICHUM, Link.—A genus of Mucedines (Hyphomycetous Fungi), growing on decaying vegetable substances, dung, &c. The forms referable to this genus, according to the character, include a very heterogeneous assemblage; indeed the character which omits the nature of the original attachment of the spores, is worth nothing. Fries has separated a genus TRICHOSPORIUM, including a number of species with distinctly acrogenous spores; this includes *S. nigrum* and *S. geochroum* of the *Brit. Flora*. The remainder are placed by him among the Sepedoniei, under *Sporotrichum* and another genus which he calls *Physospora*. These genera are very obscurely known, much resembling mycelia with detached conidia scattered on them.

BIBL. Berk. *Br. Flor.* ii. pt. 2. 346; Fries, *Sum. Veg.* 492, 495, 521; Greville, *Crypt. Flor.* pl. 108. figs, 1, 2.

SPUMA'RIA, Pers.—A genus of Myxomycetes, the peridia of which are divided internally into chambers by ascending folds, and in *S. alba* are either sessile and pass above into torn white laminæ, or are stipitate and divided, and form corniculate peridioles bursting above; the latter is probably the perfect form. The whole plant looks at first like white froth; it grows on grasses &c., generally at a little height from the ground.

BIBL. Berk. *Br. Fl.* ii. pt. 2. 309; Greville, *Crypt. Fl.* pl. 267; Sowerby, *Fungi*

(*Reticularia*), pl. 280; Fries, *Sum. Veg.* 449.

SPUMEL'LA, Cienk.—A genus of Flagellate Infusoria. Minute, free or pedicled, rounded or ovate, mouthless, with 1 long and 2 short flagella. *S. guttula* and *S. vivipara* = *Monas g.* and *v.*, Ehr. In pond water and infusions. (Kent, *Inf.* 305.)

SPU'TUM.—We omitted to notice under EXPECTORATION the occurrence of fibrinous casts of the smaller bronchi and pulmonary air-cells in the expectoration of pneumonia. They are best seen on mixing the sputa with water, forming dichotomous cylinders with rounded enlargements. They consist of fine filaments, and are mostly covered with granule-cells, and are generally met with between the third and the seventh day.

Koch's. *Bacillus tuberculosus* of phthisis, also deserves special attention.

BIBL. Remak, *Diagn. &c. Untersuch., Ed. Mn. Jn.* 1847, vii. 350; Gibbes, *Lancet*, 1882, ii. 183 & 797; *Jn. M. Soc.* 1882, ii. 572.

SPYRID'IA, Harv.—A genus of Cerami-

Fig. 693.

Spyridia filamentosa.
Fragment with a favella and ramules.
Magnified 25 diameters.

aceæ (Florideous Algæ), containing one British species, *S. filamentosa* (fig. 693), having a dull-red, cylindrical, filiform, much-branched frond, consisting of a chambered tube, the articulations of which are short, and the walls of which are composed of small angular cells. It arises from a broadly expanded disk. The branches are clothed with setaceous ramules. The *favellæ* are stalked, gelatinous, and lobed, surrounded by a few ramules and contain two or three masses of spores. The *tetraspores* occur attached to the ramules. *Antheridia* have not yet been observed.

BIBL. Harvey, *Mar. Alg.* 166, pl. 22 D.

SQUAMA'RIA, DC.—A genus of Placodei (Lichenaceous Lichens). Six species, on calcareous rocks and earth. (Leighton, *Lich. Fl.* 157.)

SQUAMEL'LA, Bory, Ehr.—A genus of Rotatoria, of the family Euchlanidota.

Char. Eyes four, frontal; foot forked; freshwater.

S. oblonga (Pl. 44. fig. 29). Carapace depressed, elliptical, or ovate-oblong, hyaline; toes slender, long; length 1-216".

S. bractea. Toes short and thick. (Ehr. *Inf.* 479.)

SQUAMULI'NA, Schultze.—An obscure, small, parasitic, scale-like, opaque Foraminifer, probably Nubecularian.

BIBL. Schultze, *Org. Polyth.* 56; Carpenter, *For.* 67.

STACHEI'A, Brady.—An adherent Arenaceous Foraminifer, with numerous subdivided chambers, acervuline or in irregular layers. Six fossil species (Carboniferous). (Brady, *Carbonif. Foram., Pal. Soc.* 1876, 107.)

STACHYLID'IUM, Link.—A genus of Mucedines (Hyphomycetous Fungi), nearly related to *Botrytis*, distinguished apparently only by the subpedicellate spores. Fries states that these are developed within a fugacious veil (?). BOTRYOSPORIUM *diffusum*, Corda, is included here by most authors. *S. bicolor* and *S. terrestre*, having quaternate sporiferous branches at the upper joints of the erect, simple filaments, grow upon decaying herbaceous plants and rotten sticks.

BIBL. Berk. *Br. Fl.* ii. pt. 2. 341; Fries, *Sum. Veg.* 490; Greville, *Crypt. Flor.* pl. 257.

STAINING.—The staining or dyeing process was introduced by Gerlach, after observing in his carmine injections, how differently the elements of the tissues were dyed by the colouring-matter.

The general action of the dye is, that the nuclei and the protoplasm of the cells are deeply coloured, while the cell-walls are but little acted upon, and the intercellular substance is hardly at all affected. The cause of this difference in the dyeing effect lies partly in the physical and partly in the chemical condition of the organic matter.

If the dye-liquor be too strong, or its action too long continued, the whole tissue will become confusedly coloured, and its elements undistinguishable.

The dyes which have been used are very

numerous; we will give a sketch of the principal and their uses.

Among these are carmine, indigo-carmine, alkaline sulphindigotates, saffron, aniline blue, eosine, fuchsine, magenta, logwood, picric acid, ink, and Judson's dyes.

Frey recommends that 3 to 6 grains of carmine (better carminic acid?) be dissolved in a few drops of *Liq. Ammon.*, with an ounce of distilled water. To the filtered liquid is added 1 ounce of glycerine, and 2 to 3 drachms of alcohol. This solution may be used alone, diluted with water, or with glycerine. The duration of the maceration will vary according to the kind of tissue and the strength of the dye-liquor; in some cases a few minutes are enough, in others 24 hours are required. The pieces of tissue are then washed with water or a very weak acid (an ounce of distilled water with 2 or 3 drops of acetic acid). Fresh tissues, or those hardened by alcohol are best; next those previously treated with chromic acid or bichromate of potash. Preparations to be preserved in feebly acidified glycerine require to be less dyed than those to be mounted in balsam.

Gerlach used a concentrated solution of carmine in ammonia, and placed the sections of brain and spinal cord, previously hardened by solution of chromic acid, in the carmine solution for ten or fifteen minutes. They were then well washed in water and treated with acetic acid; subsequently the water and acid were removed by absolute alcohol; and the preparations were then mounted in Canada balsam. Afterwards he found that better results were obtained by using dilute solution of carmine and ammonia—for instance, two or three drops of the ammoniacal solution to an ounce of water. He advised also maceration in this solution for two or three days. Beale's carmine fluid for staining protoplasm is made as follows:—

Carmine	10 grains.
Strong liquor ammoniæ	½ drachm.
Price's glycerine	2 ounces.
Distilled water	2 ounces.
Alcohol	½ ounce.

The carmine in small fragments is to be placed in a test-tube and the ammonia added to it. By agitation and heat the carmine is soon dissolved; then the solution is boiled for a few minutes and allowed to cool. After an hour any excess of ammonia will have escaped; the glycerine and water may then be added and the whole filtered. The clear fluid is to be kept in stoppered bottles; and should any carmine be precipitated, a drop or two of liquor ammoniæ should be added. Care should be taken that the solution and the tissue to be stained have not too alkaline a reaction; otherwise the staining will be too intense, and some of the tissue surrounding the protoplasm will be destroyed. The permeating power of the fluid is increased by the addition of alcohol and water. This is a most valuable staining agent, but requires care. Thiersch recommends:—carmine 1 part, caustic ammonia sol. 1 part, distilled water 3 parts; the solution is to be filtered; oxalic acid 1 part, distilled water 22 parts. One part of the carmine solution is to be mixed with 8 parts of the oxalic acid solution, and 12 parts of absolute alcohol are to be added. Should the solution turn out orange-coloured, more ammonia should be added.

A solution of carmine in borax is sometimes used—4 parts of borax dissolved in 56 parts of water, to which is added 1 part of carmine. The filtered solution is mixed with 2 volumes of alcohol. This solution answers well in dyeing cartilage.

Frey gives the following formula for Thiersch's blue staining fluid:—Oxalic acid 1 part, distilled water 22 parts, indigo-carmine as much as the solution will take up. Another solution of oxalic acid and water in the same proportion is required; and one volume of the first solution is mixed with two volumes of the last and nine of absolute alcohol. An aniline-blue solution may be made as follows:—Soluble aniline blue ½ grain, distilled water 1 oz., alcohol 25 drops. This fluid is not acted on by acids or alkalies. Magenta colours rapidly, and hence it is very useful; but its effects are not permanent. Rutherford gives the following formulæ:—Crystallized magenta 1 grain, absolute alcohol 100 minims, distilled water 5 oz. This is used for the tissues generally; and the following is for blood-corpuscles:—Crystallized magenta 1 part, rectified spirit 50 parts, distilled water 150 parts, glycerine 200 parts.

Very often nerve does not stain readily with carmine after hardening in a solution of chromic acid. This may be obviated by placing the section in absolute alcohol for a short time in order to get rid of the water; then it is placed in a solution composed of water 300 to 600 parts, and chloride of palladium 1 part. As soon as a pale straw-colour is seen on the section, it may be

removed from the solution and washed, and then placed in a strong solution of carmine and ammonia. A very few minutes will suffice to stain the axis-cylinders red and the medullary matter yellow (*Qu. Mic. Jn.* 1872, 160).

A blue staining agent, useful for treating specimens of the spinal cord, is formed by the reaction of molybdate of ammonia, iron filings, and hydrochloric acid (*Qu. Mic. Jn.* 1872, 161).

A logwood staining solution, which consists of an ounce of saturated solution of logwood and alum mixed with two drachms of 75 per cent. alcohol, is useful for the nervous elements (*Qu. Mic. Jn.* 1873, 87, & *The Lens*, July 1872).

Other staining agents comprise especially the chlorides of gold, potassium and palladium, oxide of uranium, nitrate of silver, and osmic acid. In these, except perhaps in the last, a secondary decomposition occurs before the colour is imparted to the tissues; and the greatest possible care must therefore be taken to allow for the granular or striated condition which such precipitates may assume, and for their collecting in tubes and between tissues. An excellent formula for staining ganglion-cells especially is as follows:—Bichromate of ammonia 1 to 2 per cent. solution in water. Place the fresh nerve-substance in it for 15 or 20 days. Then dip it, after having made sections, in water 10,000 parts, double chloride of gold and potassium 1 part; wash in hydrochloric acid 1 or 2 parts in 3000 water. Then dip for ten minutes in the following mixture:—Hydrochloric acid 1 part, and 1000 parts of a 60 per cent. solution of alcohol; immerse in absolute alcohol, clear with oil of cloves, and put up in Canada or Dammar balsam. Staining with chloride of gold may be conducted as follows, the object being to stain nerve-fibres:—Chloride of gold ¼ part, distilled water 100 parts. Place pieces of fresh tissue in this for a few minutes until they become tinged with yellow, then in dilute acetic acid (1 to 2 per cent.), or in concentrated tartaric acid solution for a few (10–15) minutes. Expose to light until a violet colour appears. Mount in glycerine. There is great uncertainty in the results of this process; but care and experience overcome most of the difficulties and produce magnificent preparations; nevertheless no results are worth recording which are obtainable by this process alone, and which are not the same as those visible with glycerine and carmine staining solutions. The discrepancies of observation of different and equally dogmatic observers are most instructive. In fact in some tissues the gold solution will stain many histological elements (see Klein, *Qu. Mic. Jn.* 1872, 21; and Moseley, *Qu. Mic. Jn.* 1871, 58).

Nitrate of silver for staining epithelial cement in capillaries, lymphatics, &c. The solution must be clear and weak, and of 1 part nitrate of silver to 200, 400, or 800 of distilled water. The fresh tissues must be macerated in the solution for one to three minutes, and then in a solution of dilute acetic acid (1 to 2 per cent.) for a minute or two. Then place in glycerine and expose to the light; or after removal from the nitrate-of-silver solution the tissue should be washed in distilled water, or in a weak solution of common salt before exposure to light.

In examining the tendinous centre of the diaphragm of any of the smaller mammalia, the part should be placed in the nitrate-of-silver solution and brushed over with a camel's hair pencil and then removed and treated as above.

Solution of osmic acid may be used as a hardening agent, also as a staining medium. Solution of 1 per cent., and usually of much less, blackens many tissues freely, especially the white substance of Schwann in nerves, and fat. It is very useful in investigating the minute anatomy of the Invertebrata.

Many parts of animal tissues may be stained by maceration in a weak solution of acetate of lead, washing in water, and digesting with weak hydrosulphuret of ammonia. As usual, the nuclei are rendered very black and distinct, the whole tissue being rendered brown.

Vegetable tissues may be stained in the same way as the animal structures. The aniline dyes answer best (Beatty, *Mn. Mic. Jn.* xiv. 57).

BIBL. Beale, *How &c.*; Stricker's *Hist.*, Intro.; Frey, *Mikros.*; Rutherford, *Hist.*; Jackson, *Qu. Mic. Jn.* 1874, 139; Ehrlich, *Schultze's Archiv*, 1873, xiii. 263; Gibbs, *Hist.*; Tafani, *Jn. M. Soc.* 1878, i. 82; Merbel, *Mn. Mic. Jn.* xviii. 242; Sternberg, *Jn. M. Sc.* 1882, ii. 571 (staining *Bacteria*); Schwartz, *Sitz. Ber. Wien. Ak.* 1867, lv. 671.

STAMENS.—The fertilizing organs producing the POLLEN, surrounding the pistil in perfect Flowering plants, or occurring

alone in the barren flowers of the monœcious and dicœcious genera. Stamens present a great variety of interesting points for examination under a simple microscope with a low power, in their forms, appendages, pores, &c. For the compound microscope they afford good material for the study of development of cells in the pollen, the POLLEN-grains themselves, and the spiral-fibrous tissue of their ANTHERS.

STARCH or AMYLUM.—This substance, with the exception of the protoplasm, is the most generally diffused of all the products met with in the interior of vegetable cells, and occurs in the form of transparent granules, of varied size and form and in varying quantity, in all classes of plants but the Fungi. It has been stated that it sometimes exists in a diffused or formless condition; but this seems questionable. All starch-grains appear when newly formed as minute spherical bodies, and very many never advance beyond this stage; but a considerable proportion of the grains, in all cases where the starch becomes an important and considerable element in the cell-contents, increase in size, and acquire a more or less definite form, diverging from the spherical, and often characteristic of the particular plant in which the grain is produced. The grains in a single cell mostly vary very much in size, on account of their different degrees of development; but the full-grown characteristic grains of the same species of plant agree tolerably well in size. One of the most remarkable peculiarities of starch is the fact that it assumes a blue colour when iodine is applied to it, which in most cases affords a ready means of detecting its presence. The smallest grains are almost too minute to measure, and even their determination by the application of iodine is sometimes unsatisfactory; the largest grains, such as those of *Canna* and the potato, for example, attain a length of more than 1-400".

The starch-granule is a definitely organized structure, although its existence in relation to that of the cell is transitory. It consists of assimilated food, deposited in a definite form insoluble in the ordinary cell-sap, through a process of organization analogous to that by which the development of the cell itself is effected. It is related closely to the cellulose structures of the cell-wall through the remarkable secondary layers found in the ALBUMEN of certain seeds, composed of the substance called *amyloid*, which sometimes takes a blue colour when iodine is applied to it, and, like starch, is ultimately dissolved and removed to furnish material for development.

The structure of the starch-granule has formed the subject of much debate, which, however, seems to have originated rather through considerations relating to the development than from a difficulty in observing the complete objects. Very minute granules, as above stated, appear as solid globules; but when the granules acquire appreciable dimensions, concentric lines may be observed, more or less distinctly in different cases, which lines increase in number with the increase of size, in many cases, however, soon becoming excentrical from the preponderating growth of one side of the granule. In freshly extracted granules the original centre usually appears solid or with a minute black point; but if the starch is dry, the centre appears hollow, sometimes is even occupied by air; and some starch-grains, as in *Iris pallida*, *florentina*, &c., have a large cavity. If strong alcohol is applied to fresh grains, the abstraction of water likewise produces a hollow in the central point of growth; and in all these cases, cracks not unfrequently run out towards the surface. The point in question, the starting-point of growth, solid or hollow as the case may be, is sometimes called the *hilum* or the *nucleus*: the former term arose out of the mistaken hypothesis of its being a point of attachment to the cell-wall; the latter term is admissible in a general sense as merely indicative of its precedence in age of the general mass of the grain. It is sometimes asserted that this point or nucleus is a pore or funnel-shaped cavity; but this is altogether a mistake, as may be readily proved by gently roasting a few starch-granules of the potato on a slide, and observing how the expanding air blows up the dextrine, into which the starch is changed, in the form of a bubble or bladder. Sometimes small granules occur in the potato with a large cavity and thin walls.

The lines seen in the starch-granules are the boundaries of superimposed layers of its substance; sometimes these are very distinct, sometimes very faint. Often more distinct lines appear at intervals in the series of the same granule (Pl. 46. fig. 31); and in these cases even a thin vacancy, or in the dried granules a stratum of air, seems to exist between the layers. The markings have been described as "folds" on the

starch-granules; but their dependence on the existence of the concentric layers is beyond doubt. They are seen in the proper relative positions when the granules are rolled over in all directions beneath the microscope; their relative numbers and forms correspond to the size and stage of development of the granules in the same plant; and other characters connected with the physical structure confirm the conclusions from simple inspection.

Starch is not chemically an individual substance, but consists of two independent isomeric substances: one of which, granulose, is soluble in saliva, is coloured blue by iodine, and is dissolved by weak solutions of chromic acid; while the other, cellulose, which composes from 2 to 4 p. c. only of the grains, is not affected by saliva or iodine, and is soluble in solution of cuprate of ammonia, but not in chromic acid solution.

Starch is usually stated to be unaffected by *cold water*, and this is generally the case; but if the granules of *Tous-les-mois* are crushed before placing them in water, so as to expose the internal substance, the water is sometimes absorbed by the inner layers, and these swell up considerably without the outer layers being affected. When dry starch-granules are *heated* gradually upon a slide, until some of them assume a yellowish colour, either the air-bubble above-mentioned appears—occasionally with a partial separation of the concentric layers through expansion of the films of air existing between them, while other parts become fused,—or the general shape remains unchanged, and the striæ gradually vanish, becoming melted into a mass, as it were, the starch itself being converted into dextrine. When starch-granules are *heated in water* to the boiling-point, they usually soften and "blow up" into a large sac, the inner part softening first, and pushing out the more superficial; if the sac bursts, the inner substance sometimes partly escapes in the form of cloudy flocks, but is not dissolved. *Diluted sulphuric acid* acts somewhat in the same manner as hot water; but if stronger acid is allowed to attack the granules locally or partially by flowing in from one side upon the object, very remarkable appearances present themselves: the acid touching certain parts of the granule first, or acting most quickly on softer portions, causes the softening internal layers to expand and bulge out the external layers at particular points (like *herniæ*) until the entire grain is softened, when these coalesce and the whole expands into a thin sac. Gradual action of the acid causes a more uniform expansion, which is usually accompanied by a sudden crack running out from the nucleus into the substance (indicating the abstraction of water?), followed almost immediately by a collapse of the wall above this crack, and a sudden expansion of the whole into a sac or an irregular gelatinous film. *Solution of potash* produces much the same effect as dilute sulphuric acid.

All the above appearances indicate that the starch-granule is composed of concentric "shells" of a substance of the same nature, but less dense and more rich in water in the interior layers, firmer, less hydrated, and more resisting in proportion to the distance from the starting-point of growth or nucleus; and, according to modern views, the layers are alternately more and less hydrated. With polarized light, moreover, the starch-granule exhibits a black cross, and with a plate of selenite a beautiful coloured system, especially well seen in large grains like those of the potato or *Tous-les-mois*.

Pure starch is coloured blue by iodine, whether in its natural state or softened by hot water, the depth of the colour depending on the quantity of iodine; where much is added, the colour is almost black. When dilute sulphuric acid has been added previously, the colour is rather purple than blue, especially the faint tinge given at first by weak solution of iodine. When the starch grains are heated dry, the colour given by iodine changes, proportionately to the violence of the action, from blue to purple, red-wine colour, and finally brown; the starch being converted into dextrine. The best application is the solution of iodine in iodide of potassium; and this should be used very weak in investigation of starch.

Starch-granules occur either isolated (Pl. 46. figs. 8 & 21), or in groups (figs. 7, 10, 11) (in the latter case mostly with flat faces, so as to fit together into round, oval, or similar forms), or packed closely in the parent cell in such numbers that they press upon each other and appear like parenchymatous cells (Pl. 46. figs. 3 & 12). In the actively vegetating parts of plants, starch-granules occur very generally imbedded in the green globules called CHLOROPHYLL-granules, either singly or in groups; this is seen especially well in the cells of the Confervaceæ, of the Hepaticæ, the prothallia of Ferns, in the leaves of aquatic plants, such as *Vallisneria*,

in autumn, &c. The free granules occur more particularly in the colourless organs of plants—in tubers, rhizomes, roots, and the cambium region in the season of rest, in the endosperm of ovules, or the ALBUMEN or cotyledons of seeds, &c. The parenchymatously grouped granules are found in the albumen of seeds, especially of maize and rice. The comparison of the states and of the course of development of the crowded granules of maize throws much light upon the manner in which starch-granules are formed.

In the first place, two rival doctrines exist as to the order of development of the parts of the granule. Most authors assert that the granules grow by the superposition of layers from within outwards, consequently that the outermost layers are the youngest. Other authors, especially Nägeli, comparing the granule to a cell, assert that the layers are formed internally, the older ones expanding to make room for them. There can be no doubt that the first view is correct. In the next place a variety of notions have been put forth as to the origin of the starch-granule and its relation to the rest of the contents of the cell, especially the chlorophyll. It is curious to note the error into which earlier observers fell from the want of the guiding thread furnished by a knowledge of the function of the protoplastic structures connected with the primordial utricle. The idea that the starch-granule sprouted out from the cell-wall corresponded with the original view of the origin of the septum in cell-division; while the hypothesis that starch is developed from chlorophyll, and the contrary notion that starch-granules form the nuclei of chlorophyll-granules, both rest on actual phenomena, in which, however, the chlorophyll proper, that is the mere green colouring-matter, bears no important share.

The development of the starch-granule is very beautifully illustrated in the gradual ripening of the seeds of Maize; and in imperfect seeds, different parts of the same grain often exhibit various stages of growth. The figs. 1 and 3 of Pl. 46, show the gradual formation of the starch-granules by deposition from the internal surface of *vacuoles in the protoplasm* filling the cell, exactly in the same way as the primordial utricle secretes cellulose layers upon its outer surface. Fig. 28 shows minute starch-granules originating in the same way in the protoplasm-current connected with the nucleus in the white lily; and Crüger, who first published this view in a decided form, has shown that the large granules, with an excentric hilum, originate in a similar position, and owe the excentricity of their form to the fact of their remaining imbedded at the thicker end in the protoplasmic threads of the primordial utricle, while the small free end is gradually pushed out further from the nutrient mass. The existence of starch-granules in chlorophyll-masses is thus clearly enough accounted for, now that we know the chlorophyll-globules to consist of masses of protoplasm coloured green by the presence of an extremely small quantity of a substance acquiring a green colour under the influence of light. Starch originates in vacuoles in this as in any other protoplasm. The *groups* of granules are formed through the simultaneous origin of a number, in vacuoles excavated in one large globule of chlorophyll or colourless protoplasm. We have traced this in the fronds of the Hepaticæ.

It remains to speak of the diversities of form and size of the large and perfect granules in different plants. A glance at Plate 46 will give some idea of these, and an inspection of the individual figures will show how remarkably the characteristic forms may vary in nearly related plants, even genera of the same family, as is the case with the ordinary Cereal grains. Thus in Maize (figs. 1, 3, 5), where the small grains are, as usual, originally roundish or oval (fig. 5*), they gradually press upon one another and become polygonal—in the cells of the centre of the grain, where they are less densely packed, remaining with obtuse edges and angles (fig. 5), in the cells of the horny outer part of the grain, where they adhere more or less firmly together, forming angular parenchymatous masses (fig. 3). The central cavity is large here. In the grain of Wheat we find delicate, transparent, lenticular granules (fig. 8), the striæ faint; in Barley (fig. 9) they are more irregularly discoid, with a thickened edge, the striæ obscure; while in the Oat (fig. 10) the granules are of very small size, but of angular forms and packed together in large numbers, so as to form roundish masses with a smooth surface, which readily break down into their components when pressed; the separate segments all exhibit their separate black crosses in polarized light. In Rice (fig. 12) we find somewhat similar conditions to those in Maize; but the granules are much smaller and more firmly united, whence the gritty

character of rice-flour. In the Leguminosæ, and the pea (fig. 6 *b**, p. 28), the granules are oblong, the striæ distinct, and the hilum radiate. In the Potato the starch-granules (fig. 21) are larger than any of the above; they are numerous and closely packed in the cells (fig. 20). Among the more remarkable forms of starch are the large grains of the *Cannæ* (fig. 25), *Musa* (fig. 24), and most of the Zingiberaceæ (fig. 19). Some East-Indian Arrow-root (fig. 18) has compound grains of large size (mostly detached in the prepared farina). True West-Indian Arrow-root, from *Maranta arundinacea*, is represented in fig. 26. Various other kinds are illustrated in Pl. 46. *Dieffenbachia Seguina* (Araceæ) has remarkable lobed granules.

Here may be mentioned the so-called tannin starch-grains. These resemble ordinary starch-grains, but the cellulose is replaced by tannin, the granulose being unaltered; they are coloured blue-black by iron solution, and are found in wood, seeds, &c.

Starch-granules are usually isolated by slicing the tissues in which they exist, and washing them out. When they are to be observed *in situ*, either delicate transparent structures (as in the Cryptogamia) must be selected, or sections very carefully made. The cells filled with starch of the potato (Pl. 46. fig. 20), &c., may be isolated by macerating the structures in water for a day or two. Starch-granules may be preserved for a certain time in glycerine; but they are, perhaps, best taken fresh from a store of dry granules, when required for examination.

Bibl. Martin, *Phil. Mag.* iii. 277; Busk, *Mic. Tr.* i. 58; Allman, *Mic. Jn.* ii. 163; Crüger, *Bot. Zeit.* xii. 41, *Mic. Jn.* ii. 173; E. Quekett, *Ann. N. H.* xvii. 193; Caspary, *Jahrb. wiss. Botanik*, i. 448; Trécul, *Ann. Sc. Nat.* 4. x.; Nägeli, *Stärkekörner &c.*; and *Sitzungsber. bayer. Ak.* 1865; Sachs, *Bot.* 58; Henfrey-Masters, *Bot.*

STAURAS'TRUM, Meyen.—A genus of Desmidiaceæ.

Char. Cells single, constricted at the middle; end view angular or circular, with a lobato-radiate margin, or rarely compressed with a process at each end. Sporangia generally spinous and often globose. Many British species.

S. dejectum (Pl. 14. fig. 26). Segments smooth, lunate or elliptical, constricted portion very short; end view with inflated awned lobes. Common; length 1-830″.

S. margaritaceum (Pl. 14. figs. 28, 29). Segments rough, tapering at the constriction, and with short lateral processes; end view with five or more short, narrow, obtuse rays. Length 1-1176″.

S. gracile (Pl. 14. fig. 30). Segments rough, elongated on each side into a slender process terminated by minute spines; end view biradiate. Length 1-770 to 1-540″.

Bibl. Ralfs, *Desmid.* 119; Rabenht. *Alg.* iii. 199; Archer and Dixon, *Qu. Mic. Jn.* viii. 77; *ib.* xvii. 103.

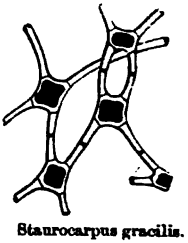
STAURIDIUM, Duj.—A genus of Hydroid Zoophytes.

Char. Stems simple or branched, rooted by a creeping filiform stolon; polypes borne at the summit of the stems with several whorls of capitate tentacula in the form of a cross.

S. productum. On marine algæ. (Hincks, *Hyd. Zooph.* 67.)

STAUROCAR'PUS, Hassall (*Staurospermum*, Kütz.).—A genus of Zygnemaceæ (Confervoid Algæ), growing in boggy freshwater pools; distinguished by the remarkable quadrate spore formed in the cross branch produced by conjugation. Hassall enumerates six species. He speaks of, but does not describe or figure, the spores of *S. cærulescens* as filled with zoospores. Thwaites, however, saw the spores of *S. gracilis* resolved into four portions; and possibly these may become converted into zoospores like the spores of Bulbochæte; or probably they germinate directly, as in *Spirogyra*.

Fig. 694.



Staurocarpus gracilis. Conjugating filaments with spores (zygospores). Magnified 100 diameters.

S. gracillimus. Filaments 1-4200″ to 1-3960″ in diam.; spores acutely quadrangular.

S. gracilis (fig. 694, and Pl. 9. fig. 16). Filaments thicker than in the last; spores cruciform.

S. glutinosus. Filaments 1-1800″ to 1-1560″ in diam.; bluish green, lubricous; spores four-sided, with the angles rounded.

S. cærulescens. Filaments about the same size as the last; spores cruciate, with obtuse lobes.

S. quadratus. Filaments 1-2400″ in diam.; spores between square and globose.

S. virescens. Filaments 1-3240 to 1-3000″ in diam.; spores cruciate, emarginate.

Bibl. Hassall, *Alg.* 176; Kützing, *Sp.*

Alg. 437; *Tab. Phyc.* v. pls. 8 & 9; Thwaites, *Ann. N. H.* xvii. 262; Ralfs, *Desmid.* p. 146; Braun, *Verjüngung*, *Ray Soc.* 1853, 287.

STAUROGE'NIA, Kütz.—A genus of Unicellular Algæ.

Char. Cubical, the cells arranged in groups of 4, 8, and 16. Propagation by tranquil gonidia arising from repeated division of the cell-substance. *S. quadratum* (Pl. 52. fig. 21). In freshwater pools.

Bibl. Rabenh. *Alg.* iii. 80.

STAURONE'IS, Ehr.—A genus of Diatomaceæ; including *Staurostigma* and *Stauroptera*.

Char. Frustules resembling those of *Navicula*, but the median nodule expanded into a transverse band or stauros.

Striæ resembling those of *Navicula*, or intermediate between those of *Navicula* and *Pinnularia*; often invisible by ordinary illumination.

The species or forms are numerous.

S. phœnicenteron (Pl. 15. fig. 43. Valves lanceolate, gradually attenuated towards the somewhat obtuse ends; stauros reaching the margins of the valves; striæ faint. Freshwater; common; length 1-170″

S. pulchella (Pl. 15. figs. 44, 45). Valves oblong, ends obtuse; frustules in front view broadly linear, constricted in the middle, and rounded-truncate at the ends; striæ distinct; stauros not reaching the margins. Marine; length 1-70′.

Bibl. Ehrenb. *Ber. Berl. Ak.* 1843; Kütz. *Bacill.* 104, and *Spec. Alg.* 89; Rabenh. *Alg.* i. 244.

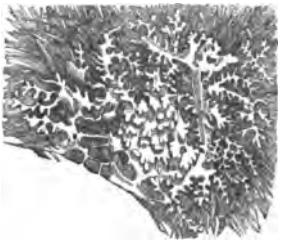
STAUROSPER'MUM, Kütz.=Staurocarpus, Hassall.

STEARIC ACID.—The crystals of this fatty acid are represented in Pl. 11. fig. 16.

STEGANOPOREL'LA, Smitt.—A genus of Polyzoa = *Membranipora* pt. (Hincks, *Polyzoa*, 176.)

STEMONI'TIS, Gled.— A genus of Myxomycetes, consisting of little, somewhat stamen-shaped plants, either separate or fasciculated, growing on rotten wood, &c. They appear at first in the form of a mucilaginous flocculent expansion (fig. 695), from which the membranaceous peridia grow up (fig. 696). Many of these remain abortive; others are raised upon stalks, ripen, and, on the separation of the fugacious peridium, display themselves somewhat in the form of Diachæa, but with a bristle-like columella and no remains of the peridium. The flat, cylindrical or globose, reticulated capillitium is penetrated partly or through its whole length by a columella continuous with the peduncle; the spores are interspersed in the reticulations of the capillitium. Capillitium and spores mostly of blackish colour. There are numerous British species; *S. fusca* is common. See Enerthenema and Diachæa.

Fig. 695.



Stemonitis ferruginea.
Mycelium overgrowing decaying pine-leaves.

Fig. 696.

Stemonitis ferruginea.
Immature (fasciculate) peridia arising from the mycelium.

Bibl. Berk. *Br. Fl.* ii. pt. 2. 317; *Ann. N. H.* i. 257, vi. 431, 2. v. 366; Greville, *Crypt. Flor.* pl. 170; Fries, *Sum. Veg.* 455; *Syst. Myc.* iii. 156.

STENHE'LIA, Boeck.—A genus of Copepodous Entomostraca. Two species, on *Laminaria* and in dredgings. (Brady, *Copep.* ii. 32.)

STENOC'YBE, Nyl.—A genus of parasitic Micro-lichens found on the thallus of *Thelotrema* and *Graphis* = *Sphinctrina*, Leighton. (Lindsay, *Q. Mic. Jn.* 1869, 146.)

STENOGRAM'ME, Harv.—A genus of Rhodymeniaceæ (Florideous Algæ), containing one very rare British plant, *S. interrupta*, characterized by stalked, flat, fan-shaped fronds, more or less divided dichotomously into riband-like lobes, 3-5″ high, of a clear pinky-red colour. It is composed of a central layer of large globular cells, with a kind of rind of small cells. The *conceptacles* form a sort of sorus or dark

line resembling a rib, up the centre of each fertile lobe. Tetraspores and antheridia unknown.

BIBL. Harvey, *Marine Alg.* 123, pl. 15 D.

STENTOR, Oken.—A genus of Heterotrichous Infusoria, of the family Bursarina.

Char. Body conical or trumpet-shaped, free, or sessile and attached by the narrow base, covered with cilia; anterior portion widened and fringed with a marginal row of longer cilia, with a spiral row of cilia extending from it to the mouth. Freshwater.

These Infusoria are among the largest and the most beautiful of the class. The body is very contractile and liable to variation in form, often becoming ovate, oblong, or globular; the nucleus is moniliform or strap-shaped. Reproduction by oblique fission, and by germs arising from the nucleus. The encysting process has been noticed in some of the species.

According to Lachmann, in *S. Müllerí*, *polymorphus*, and *Rœselii*, near the plane of the ciliary disk is a large contractile vesicle, from which a longitudinal vessel with several dilatations runs to the posterior extremity of the body; also an annular vessel round the ciliary disk, close under its row of cilia.

S. Müllerí (Pl. 32. fig. 3). Body colourless unless from containing foreign coloured particles, with a fringe of cilia or a ciliated crest extending from the mouth to near the middle of the body; nucleus moniliform. Length 1-24″

Several other species.

Dujardin places this genus in the family Urceolarina.

BIBL. Ehr. *Inf.* 261; Stein, *Infus.*, passim; Pritchard, *Inf.* 581; Clap. et Lach. *Inf.* 222; Kent, *Inf.* 588; Lankester, *Qu. M. J.* 1873 (*col. matter*).

STEPHANOC'EROS, Ehr.—A genus of Rotatoria, of the family Floscularieæa.

Char. Eyes single; rotatory organ divided into five tentacle-like lobes, furnished with whorls of vibratile cilia; body attached by the base to a cylindrical hyaline carapace.

S. Eichhornii (Pl. 44. fig. 25). The only species. Freshwater; length 1-36″. This beautiful animal uses the lobes of the rotating organ to catch its prey, in the manner of *Hydra*. At *a* (fig. 25) are seen the tremulous bodies, above which is a row of roundish globules, called by Ehrenberg nervous ganglia.

BIBL. Ehr. *Inf.* 400; Pritchard, *Inf.* 668; Cubitt, *Mn. Mic. Jn.* iii. 240.

STEPHANODIS'CUS, Ehr.—A genus of Diatomaceæ.

Char. Frustules discoidal, single; valves circular, alike, not areolar (under ordinary illumination), and with a fringe of minute marginal teeth; freshwater.

S. berolinensis has the valves finely radiate, with mostly thirty-two teeth, and is 1-1150″ in diameter. *S. Niagaræ* (Pl. 18. fig. 26); *S. lineatus* (fig. 27); *S. sinensis* (fig. 28); *S. Ægyptiacus* (fig. 29); *S. Bramaputræ* (fig. 29*).

BIBL. Ehrenb. *Ber. Berl. Ak.* 1845, lxxii.; Kütz, *Sp. Alg.* 21; Rabenht. *Alg.* i. 36.

STEPHANOGO'NIA, Ehr.—An obscure genus of fossil Diatomaceæ.

Char. Frustules resembling those of *Mastogonia*, but with the apices of the valves truncate, angular, and spinous.

Two species found in Bermuda and North America. *S. polygona* (Pl. 18. fig. 30).

BIBL. Ehrenb. *Ber. Berl. Ak.* 1844, 264; Kütz. *Sp. Alg.* 26; Pritch. *Inf.* 814.

STEPHANO'MA = PANDORINA.

STEPHANOM'ONAS, K.—A genus of Cilio-Flagellate Infusoria. Free, ovate, with an anterior circle of cilia, and a single flagellum. *S. locellus*; freshwater. (Kent, *Inf.* 466.)

STEPH'ANOPS, Ehr.—A genus of Rotatoria, of the family Euchlanidota.

Char. Eyes two, frontal, foot forked; carapace depressed or prismatic; anterior part of body expanded so as to form a frontal hood; jaws each with a single tooth.

S. cirratus (Pl. 44. fig. 28). Carapace with two posterior spines; freshwater; length 1-240″.

S. muticus has the carapace without spines posteriorly, and the eyes have not been recognized; whilst *S. lamellatus* has three posterior spines.

BIBL. Ehr. *Inf.* 478; Pritch. *Inf.* 699.

STEPHANOPYX'IS, Ehr.—A genus of Diatomaceæ = *Pyxidicula* in part.

STEPHANOSI'RA, Ehr.—A genus of Diatomaceæ.

Char. Frustules united into a short filament, disk with radiating series of minute puncta and a marginal crown of teeth. Allied to *Stephanodiscus* and *Melosira*. On trees. (Pritchard, *Infus.* 823.)

STEPHANOSPHÆ'RA, Cohn.—A genus of Volvocineæ (Confervoid Algæ). *S. pluvialis* (Pl. 48. fig. 22) is nearly related to *Pandorina*, consisting of a large hyaline

globe with eight biciliated green cells, placed at equal distances on the equator.

Bibl. Cohn, *Sieb. & Köllik. Zeitschr.* iv. 77, *Ann. N. H.* x. 321, pl. 6; *Mic. Jn.* vi. 131; Rabenh. *Alg.* iii. 100; Archer, *Qu. Mic. Jn.* 1865, 116.

STEREOCAU'LON, Schreb.—A genus of Cladodei (Lichenaceous Lichens). *S. paschale*, the most distinct species, is abundant on rocks and stones in mountainous districts. Thallus greyish and rough, apothecia conglomerated, blackish brown; spermogonia in little brown heads, near the apothecia. Other species.

Bibl. Hook. *Br. Fl.* ii. pt. 1. 237; Tulasne, *Ann. Sc. Nat.* 3. xvii. 197; *Engl. Bot.* pl. 282; Leighton, *Lich. Fl.* 69.

STEREONE'MA, Kütz.—A supposed Alga of the family Phæonemeæ (Kützing), stated by Cohn, however, to consist of the decaying stalks of Anthophysa. (Kütz. *Sp. Alg.* 160.)

STE'REUM, Fr.—A genus of Auricularini (Hymenomycetous Fungi), characterized by its coriaceous substance, and even hymenium without bristles, as in *Hymenochæte*.

The species are numerous, amongst which *Stereum hirsutum* is one of our commonest Fungi.

Bibl. Fr. *Ep.* 548; Berk. *Outl.* t. 17. f. 7; Cooke, *Handb.* 316.

STERIG'MATA.—The term applied by Tulasne to the filaments forming the pedicels of the spermatia in the Fungi (Pl. 26. figs. 2, 3).

STERROM'ONAS, Kent.—A genus of Flagellate Infusoria. Free, elongate, with two flagella, the longer rigid, the shorter flexible and vibratile. *S. formicina*, in vegetable infusions, salt and freshwater. (Kent, *Inf.* 420.)

STICHID'IA.—Pod-shaped processes of the fronds of Florideous Algæ, containing the tetraspores imbedded in them (fig. 157, p. 236).

STICHOCHÆ'TA, Cl. and Lachm.—A genus of Hypotrichous Infusoria, fam. Oxytrichina. Free, elongate, narrowed and with cirri in front, and with styles and setæ behind. *S. pediculiformis*; marine. (Kent, *Inf.* 775; Cl. & Lachm. *Inf.* 152.)

STICHOCOC'CUS, Näg.—A genus of Palmellaceæ, consisting of very minute, oblong, thin-walled, green cells, single, or usually arranged in rows. *S. bacillaris* (Pl. 3. fig. 25), on damp decaying wood, especially of willows, walls, &c. (Rabenhorst, *Fl. Alg.* iii. 47.)

STICHOSTE'GIA, D'Orb. (Rhabdoidea, Schultze).—D'Orbigny arranged all Foraminifera having uniserial or linear growth under this head as an Order; but, besides the many straight *Nodosarinæ*, there are several rectilinear forms of other genera belonging to different Natural Orders, as *Lituola, Pavonia, Articulina*, &c.

STICHOT'RICHA, Perty.—A genus of Hypotrichous Infusoria. Elongate, variable, narrowed in front; outer anterior cilia very long, in a lateral row; often contained in a cylindrical carapace.

Several species; salt and freshwater. (Kent, *Inf.* 775; Perty, *Lebensf.* 153.)

STIC'TA, Ach.—A genus of Phyllodei (Lichenaceous Lichens), with a tough foliaceous thallus, growing over rocks and trunks of trees, mostly in mountainous districts. *S. pulmonaria* forms large shaggy fronds of olive-green colour when fresh, pale-brown when dry, pitted and reticulated; apothecia mostly marginal, red-brown. Spermogonia occur scattered on the upper surface, mostly near the ends of the lobes.

Bibl. Hook. *Br. Fl.* ii. pt. 1. 208; Tulasne, *Ann. Sc. Nat.* 3. xvii. 169, pl. 1; *Engl. Bot.* pl. 572; Leighton, *Lich. Flor.* 111.

STIC'TEI, Fries.—A group of Helvellacei (Ascomycetous Fungi), containing

Fig. 697.

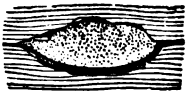


Fig. 698.

Fig. 699.

Stictis versicolor.

Fig. 697. An open disk, emerged on the surface of wood, having an irregular border.

Fig. 698. Vertical section of the same.

Magnified 20 diameters.

Fig. 699. Asci and paraphyses from the last. Magnified 200 diameters.

several genera of plants, growing on wood,

branches of trees, &c., bursting through from beneath the bark when mature. *Stictis* (*Cryptomyces*, Berk.; *Propolis*, Fr., *S. Veg.*) *versicolor* (figs. 697–699) is common on wood; the upper surface of the open fruit is white, and at length mealy.

BIBL. Berk. *Br. Fl.* ii. pt. 2. 214; *Ann. N. H.* vi. 359; Fries, *Sum. Veg.* 372.

STIC'TINA, Nyl.—A genus of Phyllodei (Lichenaceous Lichens). Thallus variously lobed or laciniato-lobate; rhizinæ simple; granula gonima of a dark blue-green colour. (Leighton, *Lich. Fl.* 108.)

STICTODIS'CUS, Grev.—A genus of Diatomaceæ. *S. Hardmanianus*, in the Monterey deposit. (Grev. *Mic. Tr.* 1865, 98.)

STIGEOCLO'NIUM, Kütz.—A genus of Confervoid Algæ, doubtfully referred to Confervaceæ, growing mostly in brooks, and composed of delicate branched filaments, drawn out into delicate hyaline points; attached to stones and forming masses of a mucous or lubricous character. The jointed filaments are composed of short cells, possessing bright green contents; the entire contents of a cell are converted into a single spore (with four cilia) and discharged (Pl. 9. fig. 5); and the cell-wall is so delicate that it generally vanishes at the same time. Many species are described by Kützing, formerly regarded as members of the genus DRAPARNALDIA, which differs in the number of spores produced in each cell, and in possessing large primary filaments with lateral tufts of delicate ones, resembling those of *Stigeoclonium* (fig. 179, p. 271).

S. protensum (Pl. 9. fig. 5). Tufts of filaments 1-36 to 1-60″ high, very much branched and elongated; primary filaments 1-1800″ in diameter, joints equal or three times as long (*Drap. condensata*, Hassall).

S. tenue. Tufts about 1-36″ to 1-72″ high; filaments 1-2160″ in diam., torulose; set above with tufts of abbreviated branchlets (*Drap. tenuis*, Hass.)

S. elongatum. Filaments very slender, 1-2880″ in diam.; branches erecto-patent, often opposite, subramulose, flagelliform; joints three or five times as long as broad (*Drap. elong.* Hass.).

S. nanum. Filaments highly mucous, very slender, sparingly branched, branches acuminate, not usually ciliate; cells rather broader than long (*Drap. nana*, Hass.).

BIBL. Kütz. *Sp. Alg.* 352; *Tab. Phyc.* iii. pls. 1-11; Hassall, *Br. Alg.* p. 118; Thuret, *Ann. Sc. Nat.* 3. xiv. 223, pl. 18; Rabenh. *Alg.* iii. 375.

STIG'MA.—The part of the pistil of Angiospermous Flowering Plants, upon which the pollen rests to produce its pollen-tubes, and where the orifices exist leading to the cavity of the ovary. It is situated either at or near the summit of the style or its branches; or, when this is absent, it is sessile on the ovary. The surface of the stigma is clothed with papilliform or short tubular cells, from which a tenacious secretion exudes at the period when the ovules are prepared to receive the pollen-tubes. Attached by this adhesive fluid and often grasped by the papillæ the pollen-grains produce their tubes, which make their way between the papillæ to descend through the conducting tissue of the style to the placenta (Pl. 40. fig. 30). These papilliform cells in a young state often form favourable subjects for the study of the protoplastic cell-contents, and also of the fluid colouring-matter. The forms of the stigma are exceedingly varied and sometimes very elegant; and some of those covered with coloured hairs form beautiful microscopic objects. In the Order Compositæ, its characters are used for the systematic division of the numerous genera.

STIGMÆ'US, Koch.—A genus of Trombidina (Acarina). Legs seven-jointed, cephalothorax with transverse line; no eyes. *S. cruentus*, very minute. (Koch, *Uebers.*; Murray, *Ec. Ent.* 124.)

STIGMAPH'ORA, Wallich.—A genus of Diatomaceæ.

Char. Frustules free, naviculoid; valves lanceolate, loculate; loculi with central and marginal puncta; marine. India.

BIBL. Wallich, *Tr. Mic. Soc.* viii. 43; Rabenht. *Alg.* i. 258.

STIG'MATA OF ANIMALS. See SPIRACLES.

STIGMATID'IUM, Mey.—A genus of Graphidei (Lichenaceous Lichens). Apothecia brownish, punctiform or elongate, immersed, hypothecium colourless. (Leighton, *Lich. Flora*, 412.)

STIGONE'MA, Ag.—A supposed genus of Oscillatoriaceæ, founded upon what has proved to be the thallus of a genus of Lichens. See EPHEBE.

STILBA'CEI.—A family of Hyphomycetous Fungi, growing upon decaying animal or vegetable matter, or on bark or leathery leaves. Characterized by a receptacle composed of conjoined filamentous or hexagonal

cells and spores borne singly on the apices of free filaments, forming a gelatinous mass. Some of the Fungi here included are heterogeneous and imperfectly studied; for example, *Tuberculariа* and *Fusarium* are apparently only imperfect states of other Fungi, while the more distinct genera appear to be referable to the family Dematiei.

Synopsis of British Genera.

Stilbum. Receptacle stalked at the base, clavate or capitate at the summit, composed of coalescent, densely crowded, parallel filaments; spores simple, arising singly at the apices of free filaments.

Atractium. Stem firm. Head subglobose; spores fusiform, elongated.

Myrothecium. Receptacle at length marginate. Spores diffluent, oblong, forming a flat or slightly convex, dark green stratum.

Tuberculariа. Receptacle wart-shaped, globular or stalked, fleshy, composed of continuous sterile, and thread-like beaded fertile filaments. Finally indurated, floccose, with the spores scattered over it, or falling into powder.

Periola. Receptacle cellular, sessile; fertile filaments abbreviated, torulose, mixed with septate lax sterile filaments.

Volutella. Receptacle wart-like, cellular, compact, with long, rigid bristles; spores spindle-shaped, septate, on continuous short filaments, arising all over the receptacle.

Fusarium. Receptacle wart-like, cellular, gelatinous; spores spindle-shaped, simple, somewhat curved, borne on simple filaments arising all over the receptacle, and forming a discoid stratum.

Illosporium. Receptacle wart-shaped, subgelatinous, diffluent; spores simple, pellucid, generally with a hyaline envelope, borne on short filaments.

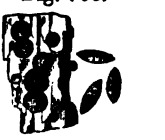
Epicoccum. Receptacle wart-shaped, cellular, for the most part seated on an effused patch; spores four-sided, cellular, attached singly to very short, continuous filaments.

Ægerita. Spores irregular, disposed in short moniliform threads at the apices of flexuous, branched, radiating, compacted peduncles.

Bibl. Berkeley, *Crypt. Botany*, 311.

STILBOSPORA, Pers. — A supposed genus of Melanconiei (Stylosporous Fungi), but apparently only consisting of stylosporous fruits of *Sphæriæ*. These grow upon wood, sticks, &c., breaking forth on the surface without any distinct perithecium, consisting of a nucleus composed of agglutinated (septate) stylospores (see Sphæria).

Fig. 700.



Stilbospora macrosperma. Group of conceptacles breaking forth on a fragment of wood; nat. size. The detached spores on the right-hand magnified 150 diameters.

Bibl. Berk. *Br. Flor.* ii. pt. 2. 356; *An. N. H.* vi. 355; *Hooker's Jn. of Bot.* iii. 322; Fries, *Sum. Veg.* 508; Fresenius, *Beitr. z. Myc.* ii. 63; Tulasne, *An. Sc. Nat.* 4. v. 109.

STIL'BUM, Tode.—A genus of Stilbacei (Hyphomycetous Fungi), containing a considerable number of species, forming little shining mildews, sometimes brightly coloured, on decaying wood, herbaceous plants, fungi, &c. The stalk-like stroma is sometimes villous, sometimes glabrous and rigid, sometimes pellucid and soft; it is formed of conjoined filaments, the free ends of which bear the spores in a capitulum, which finally exhibits a gelatinous character.

Bibl. Berk. *Brit. Fl.* ii. pt. 2. 330; *Ann. N. H.* vi. 432, pl. 12; *ib.* 2. v. 465; Fries, *Sum. Veg.* 469.

STILOPH'ORA, J. Ag.—A genus of Sporochnaceæ (Fucoid Algæ), included by some authors among the Dictyotaceæ. There are two British species, *S. rhizodes* and *S. Lyngbyei*, characterized by a branched, filiform, at first solid, afterwards tubular frond, the former 6 to 24″, the latter 2 to 4″ long, arising from a small naked disk. The fructification consists of little wart-like bodies scattered all over the frond, composed of tufts of moniliform filaments, at the bases of which are attached either pyriform unilocular, or tubular septate sporanges. Thuret states that the specimens of *S. rhizodes* found a certain distance above low-water mark appear mostly to bear septate, those always under water simple sporanges, and those in an intermediate position exhibit both. The plants of the first kind are of paler colour than those of the second.

Bibl. Harvey, *Mar. Alg.* 39, pl. 7 C; Greville, *Alg. Brit.* pl. 6; Thuret, *Ann. Sc. Nat.* 3. xiv. 238, pl. 38.

STING of Insects.—The well-known sting of the females or so-called neuters of Hymenopterous Insects, as the honey-bee, the humble-bee, the hornet, the wasp, &c., appears to the naked eye to be a single needle-like organ; but when examined under the microscope, it is seen to consist of

three pieces—a short, stout, cylindrico-conical outer piece or sheath (Pl. 34. fig. 14 *a*), cleft throughout its length on the under surface and obtuse at the end, within which are partly contained two long elbowed setæ or lancets (Pl. 34. fig. 15, one of them), thickened and furnished with teeth directed backwards near the end of one margin, the other margin sharp and cutting. These setæ play within the sheath, being partially protrusile and retractile, as is the sheath itself. The poison-apparatus consists of two glandular elongated sacs, either simple (Pl. 34. fig. 14 *e*, *f*), or branched as in the humble bee, &c., and terminating by one (fig. 14 *d*) or two ducts, in a muscular reservoir (fig. 14 *c*), from which an excretory duct runs to the base of the sheath of the sting.

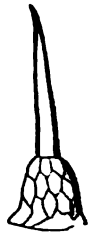
The irritation produced by the sting of one of these insects needs no remark. It does not, however, serve a merely defensive purpose, but is used also to paralyze the prey, so that it may be kept in store for future use.

The sting represents a modified ovipositor.

Bibl. Lacaze-Duthiers, *Ann. Sc. Nat.* 3. xii. xiv. &c.; Westwood, *Introd.*; Siebold, *Vergl. An.*

STINGS OF PLANTS. — These are epidermal structures, consisting of large hairs, with a bulbous base more or less included in a cellular coat, and attenuated upwards. In the sting of the nettle the apex is expanded into a little bulb, which is broken off when the sting is lightly touched (Pl. 28. fig. 8). Young stings

Fig. 701.



Stinging hair of Nettle. Magn. 20 diams.

Fig. 702.

Fig. 703.

Fig. 704.

Fig. 702. Gastric mucous gland with cylinder-epithelium, from the pylorus of a dog. *a*, principal cavity; *b*, tubular processes arising from it. Magnified 60 diameters.

Fig. 703. Gastric peptic gland from the middle of the stomach. *a*, principal cavity; *b*, primary, and *c*, terminal branches arising from it. Magnified 60 diameters.

Fig. 704. Portions of a terminal branch, the upper representing a longitudinal, the lower a transverse section. *a*, basement membrane; *b*, large cells in close apposition with it; *c*, smaller epithelial cells surrounding the cavity. Magnified 350 diameters.

exhibit the ROTATION. Stings occur not only in the nettles (*Urtica*), but in the cultivated Loasaceæ (*Loasa*, *Bartonia*, &c.), and of much larger size in some exotic Urticaceæ and Euphorbiaceæ.

See HAIRS, page 378.

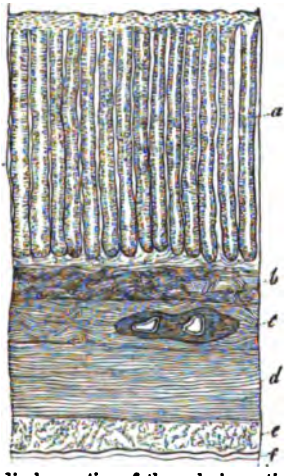
STI'PA, Linn.—A genus of Graminaceæ. The fibres of the culms of *S. tenacissima* are used in the manufacture of paper.

STOMACH.—The glands which secrete the gastric juice, or the peptic glands, are tubular, and placed perpendicularly beneath the surface of the mucous membrane, and extending as deeply as the muscular coat of the stomach.

They vary in length from 1-60 to 1-12", are cylindrical, somewhat narrowed towards the closed end, which is rounded or somewhat inflated. The lower third is wavy or spiral, especially in the glands occupying the pylorus; some of them also give off a cæcal branch.

The peptic glands consist of a delicate basement membrane, lined in the upper third with cylindrical epithelium, the lower portion being filled with large, pale, polygonal, finely granular cells, not arranged in a laminated form.

Fig. 705.



Perpendicular section of the pyloric portion of the stomach of a pig. *a*, glands; *b*, muscular layer of the proper mucous membrane; *c*, submucous tissue with the orifices of divided vessels; *d*, transverse muscular layer; *e*, longitudinal ditto; *f*, serous coat. Magnified 30 diameters.

In many animals the gastric glands are of more complicated structure than in man, and two distinct kinds exist—in one, secreting mucus, the tubes being lined with cylindrical epithelium; whilst in the other, which secretes gastric juice, rounded epithelial cells occur, and the walls are expanded at intervals.

Closed follicles resembling the solitary glands of the small intestines are met with in the stomach; they are inconstant, however, and variable in number.

The stomach is lined by cylindrical epithelium.

BIBL. Kölliker, *Mik. An.* ii. 137, and the Bibl. therein; Todd and Bowman, *Phys. An. &c.*; Brinton, *Todd's Cycl. An. & Phys.* Art. *Stomach*; Klein, *Stricker's Hist.* i. 343.

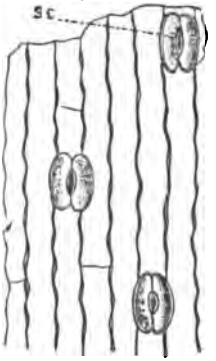
STOM'ATA (plural of STOMA).—The name applied to the structures which constitute the passages of communication, through the EPIDERMIS of plants, from the intercellular passages to the external air. They occur almost exclusively on the green parts of plants, and are usually absent from the epidermis of roots, and the surface of all structures growing under water. The lowest classes which present them are the Liverworts and Mosses, where, however, they are limited to a few kinds, and in the former present a peculiar organization. In the Ferns they are distributed just as in the Flowering Plants, where they occur principally upon the leaves (fig. 706), especially upon the lower face, but extend also over the green shoots, the parts of the flower (fig. 200, page 296), and even into the interior of cavities, as on the epidermis of the *replum* of Cruciferæ (wallflower), and still more remarkably on the epidermis of seeds (skin of the walnut).

In the Liverworts the stomata occur on the fronds and receptacles of certain genera (*Marchantia*, *Fegatella*, &c. &c.). In *Marchantia* (fig. 447, p. 489), they are somewhat circular orifices in the epidermis, guarded by cells arranged in three or four tiers. In the Mosses they are met with on the apophyses or thickened summits of the setæ bearing the capsules, as in *Funaria* (fig. 262, page 343). The structures here resemble those in the higher plants, as is the case also with those on the leaves of Ferns.

In the Flowering Plants the perfect stomata appear as roundish or sometimes squarish chasms in the epidermal layer, occurring regularly at the meeting angles or sides of four or more epidermal cells, the chasm forming an orifice leading down to a subepidermal intercellular space, and guar-

ded a little below the upper edge, more deeply, or even at the bottom, by usually two semilunar cells, applied together by their flat faces, but not coherent, their convex surfaces adhering firmly to the sides of the epidermal gap. According as the two stomatal cells—pore-cells or guard cells—are distended or collapsed, their flat faces approach or retreat from each other, in the latter case leaving a slit-like orifice leading from the outer passage into the subepidermal space. Sometimes the guard cells are four in number, in which case they either form two tiers, as upper and lower (Proteaceæ, *e. g. Hakea, Protea*, &c.), or they are in the same line and parallel, forming inner and outer guard cells (*Ficus elastica*). In certain coriaceous leaves the stomata are placed on the sides of pits excavated beneath the surface of the leaves, as in *Dasylirion longifolium* and *Nerium Oleander*.

Fig. 706.



Epidermis of the White Lily with stomata *st* (lower surface).
Magnified 100 diameters.

A considerable difference exists between the appearances presented by vertical sections of the epidermis of leaves made so as to pass through the stomata. In young leaves the guard cells are little (if at all) below the general level of the epidermis; and the same is the case with the perfect forms of various herbaceous plants in which the leaves are of membranous texture. In other cases, as in the Hyacinth, *Iris, Narcissus, Equisetum*, &c., the guard cells are found at a very early period quite beneath the layer of epidermal cells, attached as it were *under* the passage communicating with the air. The same occurs very frequently in the stomata of coriaceous leaves, as in *Aloe* (Pl. 48. fig. 22), *Ficus, Cycas, Hakea, Protea*, &c. In other instances also in leathery leaves, the guard cells appear more or less elevated *above* the general level of the epidermal cells, as in some species of *Leucadendron, Grevillea*, &c. It is important to observe that in the cases where the guard cells are sunk in the orifice of the epidermis, the upper margin of the orifice, formed by the borders of the surrounding epidermal cells, sometimes becomes elevated and even converted into a kind of perforated dome (Pl. 48. fig. 22) by development of the cuticular layers (see Epidermis). This might be mistaken for the stoma itself. The same cuticular substance is often developed in mature leaves, not only down over the walls of the stomatal passage, but over the guard cells, and thence more or less into contiguous intercellular passages. This may be observed in *Euphorbia Caput-Medusæ, Helleborus niger* and *viridis, Betula alba, Asphodelus luteus*, and *Cereus*, some *Aloeæ*, &c. Gasparini obtained these connected processes of cuticular substance, in the form of an isolated coherent piece, by boiling epidermis in nitric acid, which dissolved the adjoining cell-walls: these he mistook for peculiar organs, and called them *cystomes*. Hooker has described a remarkable form of stomata in the parasitical plant *Myzodendron*.

In those plants in which the epidermis becomes infiltrated with siliceous matter, the walls of the stomatal pore and the guard cells become imbued with it, and a siliceous skeleton of the structure remains after the organic matter has been removed by nitric acid and burning (Pl. 48. fig. 29). This is readily seen in the Equisetaceæ, especially *E. hyemale*, also in the Grasses.

The mode of development of the stomata appears to be uncertain. Mohl and other authors assert that the guard cells originate from one of the cells of the subepidermal tissue, which is pushed up into a vacancy formed by the separation of the epidermal cells at certain points. This cell is next divided into two, which become free from each other in the line of the new partition then formed. Nägeli and others assert that the guard cells are originally constituent cells of the epidermal layer, which become subsequently displaced downwards (or upwards), and undergo special development analogous to that just described. In the Iridaceæ, Equisetaceæ, and some other plants, the process is more complicated.

The stomata are generally largest upon succulent leaves, smallest on hard and leathery kinds; their form and number are most varied, both in different plants and on different parts of the same plant. They abound most on the lower face of leaves; but it has been mentioned that they are not found on submerged organs, and on floating

leaves they occur only upon the upper face. The larger kinds are more scattered on a given surface; the smaller occur closer together: this depends, of course, on the general character of the epidermal and subjacent tissue. The numbers have been estimated upon the surfaces of many leaves, of which a few examples may be given: thus a square inch contains, on the

	Upper surface.	Lower surface.
Carnation	38,500	38,500
Garden Flag	11,572	11,572
House-leek	10,710	6,000
Tradescantia	2,000	2,000
Mistletoe	200	200
Holly	0	63,600
Lilac	0	160,000
Vine	0	13,600
Laurestinus	0	90,000

BIBL. *General Works on Struct. Botany*; Mirbel, *Mém. Ac. Roy. France*, xii.; Gasparini, *Nuove ric. s. strutt. d. Cistomi*, 1844; Garreau, *Ann. Sc. Nat.* 4. i. 213; Hooker, *Flora Antarct.* i. 291; Biscoe, *Mn. Mic. Jn.* viii. 31.; Hohnfeldt, *Bot. Centralbl.* 1880, i., *Jn. Mic. Soc.* 1881, i. 71 (underground); Prantl, *Flora*, 1872; Stein, *Bot.* 103.

STOMATA or STIGMATA of Animals.—These are minute rounded spaces, left between the epithelial cells of the capillary blood-vessels, lymphatics, and of the serous membranes. Great importance has been attributed to them, as allowing the escape of the corpuscles and liquid into the surrounding tissues. This may occur when the vessels are congested and distended; but not in the normal state, for the finest injections do not escape through them. They are best seen in silver-stained preparations. (Frey, *Hist.* and the Bibl.)

STOMATOP'ORA = ALECTO.

STONES OF FRUITS, such as cherries, plums, &c., afford excellent materials for sections, showing extreme development of the woody SECONDARY DEPOSITS of vegetable cells.

STORTHOSPHÆ'RA, Schulze.—A globular Arenaceous Foraminifer with a short blunt spike. German Ocean. (F. E. Schulze, *Commiss. wiss. Un. deutsch. Meere*, 1875, 113.)

STRIA'RIA, Grev.—A genus of Dictyosiphonaceæ (Fucoid Algæ), nearly related to Punctariaceæ, having a branched, filiform pale olive, tubular frond, arising from a shield-shaped naked disk. The walls of the tube are membranous, and the cavity without septa. *S. attenuata* (fig. 707) grows from

Fig. 707.

Striaria attenuata.

Fig. 707. Part of a frond. One-third of the nat. size.

Fig. 708.

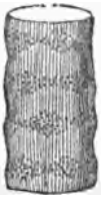
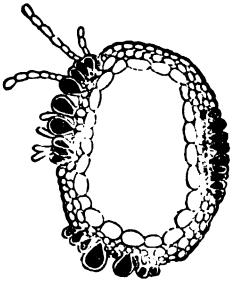


Fig. 709.



Striaria attenuata.

Fig. 708. A fragment with sori. Magnified 5 diams.
Fig. 709. Section of a fertile branch, with sori. Magnified 25 diameters.

3 to 12″ high. The branches are attenuated towards each end, and marked with rings consisting of clusters of simple sporanges (spores) (fig. 708), sometimes accompanied by filaments (fig. 709).

BIBL. Harv. *Mar. Alg.* 41; Grev. *Alg.* 54.

STRIATEL'LA, Ag.—A genus of Diatomaceæ.

Char. Frustules with a stipes attached to one angle, depressed, tabulate; with longitudinal uninterrupted vittæ, apparently thickened at each end. Marine.

The vittæ appear as dark lines; no transverse striæ are visible under ordinary illumination.

S. unipunctata (Pl. 17. fig. 20), Frustules in front view quadrangular, often broader than long, lateral margins subulate; valves narrowly lanceolate; stalk elongate, simple, filiform and thickish. Length of frustules 1-450 to 1-280″.

Bibl. Kütz. *Bacill.* 125; *Sp. Alg.* 114; Rabenht. *Alg.* i. 307; Grunow, *M. M. J.* xviii. 171.

STRIG'ULA, Fries.—A genus of Pyrenodei (Lichenaceous Lichens), containing one British species, *S. Babingtonii*, growing on the leaves of box and other evergreens. Thallus subepidermal; asci containing eight cymbiform triseptate spores.

Bibl. Leighton, *Lich. Fl.* 498; Berk. *Eng. Bot.* Supp. pl. 2057.

STROMBID'IUM, Cl. & Lach.—A genus of Peritrichous Infusoria, fam. Halterina.

Char. No setæ for leaping, essentially swimmers. 8 species; marine and freshwater. (Cl. & Lachm. *Inf.* 371; Kent, *Inf.* 631.)

STROMBIDINOP'SIS, Kt.—A genus of Heterotrichous Infusoria. Free, ovate, ciliated; anterior cilia longer, forming a wreath of one or more turns. *S. gyrans*; freshwater; length 1-350″. (Kent, *Inf.* 614.)

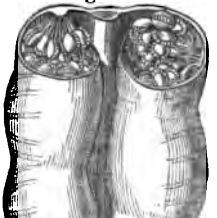
STRONGYLID'IUM, Sterki.—A genus of Hypotrichous Infusoria. Like *Uroleptus piscis*, but with a thicker twisted body, and frontal and anal styles. (Kent, *Inf.* 779.)

STRON'GYLUS, Müll.—A genus of Nematoid Entozoa. The species are very numerous. *S. pergracilis* is the cause of the grouse-disease. *S. sanguisuga* is allied to *Anchylostoma*, inhabits the human small intestine, sucking the blood and producing anæmia. (See the Bibl. of Entozoa, and Dounon, *Parasites.*)

STRONTIA or STRONTIAN. — The crystals of the sulphate of this earthy base are figured in Pl. 10. fig. 18, to contrast with those of the sulphates of baryta and lime.

STRUTHIOP'TERIS, Willden. = *Onoclea*, pt.—*S.* (*Onoclea*) *germanica*, fig. 710.

Fig. 710.



Struthiopteris germanica. Portion of a pinna with the rolled margins covering the sori. Magnified 40 diameters.

STRYCHNINE, or Strychnia. See Alkaloids, p. 31.

STYLOBIB'LIUM, Ehr.—A genus of fossil Diatomaceæ.

Char. Frustules circular, single, compound; valves contiguous, in a single row, like the leaves of a book, the inner ones with a large median aperture (?), the outer not being perforated but sculptured.

S. clypeus (Pl. 18. fig. 50 *a*, *b*); *S. divisum* (fig. 50 *c*); *S. eccentricum* (fig. 50 *d*). It is uncertain whether the so-called inner valves are merely hoops, or the valves of imperfectly separated frustules; also whether they are perforated or not, for neither Ehrenberg nor Kützing can be relied on for distinguishing a perforation, as evidenced by their erroneous description of the structure of the valves of *Pinnularia*, *Grammatophora*, and many other Diatomaceæ.

Three species are described, occurring in America and Siberia. The sculpturings upon the outer valves consist of radiating or excentric curved lines.

Bibl. Ehr. *Ber. Berl. Ak.* 1845; id. *Mikrog.*; Kütz. *Sp. Alg.* 16; Rabenht. *Alg.* i. 302.

STYLOB'RYON = *Dinobryon* pt.

STYLOCHO'NA, Kt.—Like *Spirochona*, but with distinct stalks. 2 species; on *Nebalia* and *Gammarus*. (Kent, *Inf.* 662.)

STYLOCHRYS'ALIS, Stein.—A genus of Flagellate Infusoria. Ovate, pedicled; flagella 2, equal; two lateral pigment-bands; freshwater. *S. parasita*, on *Eudorina elegans*. (Kent, *Inf.* 405.)

STYLO'COLA, De From.—A genus of Peritrichous Infusoria. Body as in *Vaginicola*, but attached to the sheath by numerous fibres. Two species; freshwater. (Kent, *Inf.* 730.)

STYLONE'THES, Sterki.—A genus of Hypotrichous Infusoria. *S. tardus.* (Kent, *Inf.* 782.)

STYLONICHIA, Ehr.—A genus of Hypotrichous Infusoria, fam. Oxytrichina.

Char. Body ciliated, and furnished with styles and hooks.

In this genus, transverse and longitudinal division, gemmation, and the encysting process have been observed.

S. mytilus = *Kerona mytilus*, D. (Pl. 31. figs. 27, 28). Body white, hyaline at each end, flat, oblong, slightly constricted in the middle, dilated at the oblique fore part; freshwater; length 1-240 to 1-100″.

S. pustulata = *Kerona pustul.* D. (Pl 31. fig. 26). Body white, turbid, oblong, with a median ventral band of hooks; fr. wat.; length 1-144″.

S. histrio (Pl. 31. fig. 29). Body white, elliptical-oblong, hooks aggregated into an anterior heap; no setæ; fr. wat.; length 1-290 to-1220″; probably a variety of *S. pustulata.*

S. lanceolata (Pl. 31. fig. 30). Body lanceolate, pale green, obtuse at the ends; ventral surface flat; hooks acervate near

the mouth; styles none; fr. wat.; length 1-140 to 1-20″.

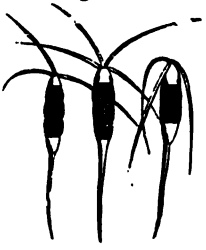
Bibl. Ehr. *Inf.* 370; Stein, *Inf.*; Claparède et Lachm. *Inf.* 154; Kent, *Inf.* 790.

STYLOPLO'TES, Stein = *Stylonichia* pt.

STYLOSPOR'EI.—These fungi were formerly included in the Coniomycetes; but their external resemblance to the Pyrenomycetes, of which they are indeed forms, makes it desirable to give them a separate name.

STY'LOSPORES.—Stalked spores of Coniomycetous Fungi, usually compound or septate, then probably consisting of a row of independent spores connected by an adherent parent sac—thus, structurally, metamorphosed asci; they are some times appendaged above (fig. 711) (see Spores and Coniomycetes).

Fig. 711.



Stylospores of Pestalozzia. Magnified 200 diameters.

STYSA'NUS.—A genus of Dematiei (Mucedinous Fungi), characterized by a stem consisting of an aggregation of threads, bearing above at their extremities simple or necklaces of spores. *S. Caput-Medusæ* (fig. 346, p. 406).

SUBLIMATION.—The application of this process in the detection of arsenic and antimony is alluded to at p. 73; but its utility has been further shown in regard to several other inorganic and organic substances—a little of the substance being placed in a cup-like hollow in a piece of platinum-foil, a cover laid on, and heat applied until fusion and sublimation takes place, when the characteristic crystals are found (Alkaloids).

Bibl. Guy, *Pharm. Jn.* 2. viii. & ix.; Helwig, *D. Mikr. in d. Toxicologie*, 1865, 64 microphotographs.

SUCCINIC ACID.—This acid, which occurs in amber, in all fermented liquids, and in the contents of *Echinococcus*-cysts, is pretty soluble in water, readily in hot but with difficulty in cold alcohol, and but little in ether. The crystals belong to the oblique prismatic system, and are represented in Pl. 11. fig. 21.

Bibl. That of Chemistry.

SUDORIP'AROUS GLANDS.—These organs secrete the perspiration.

They are found in most parts of the skin, but in variable numbers in different localities. Thus it has been estimated that 417 exist in a square inch of the skin of the back of the hand, 1093 in an inch of the outside, and 1123 in the inside of the forearm, and 2736 in an inch of the palm of the hand.

Each gland consists of a long tube coiled

Fig. 712.

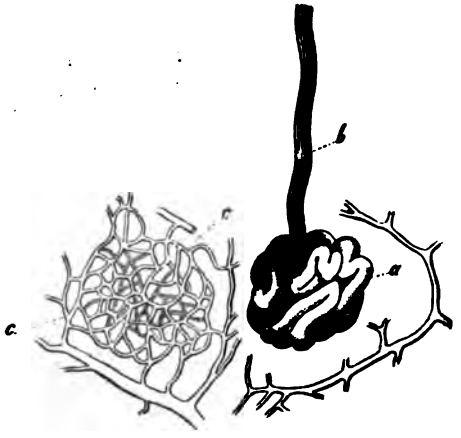


Fig. 713.

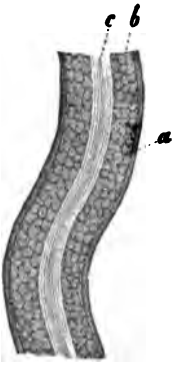


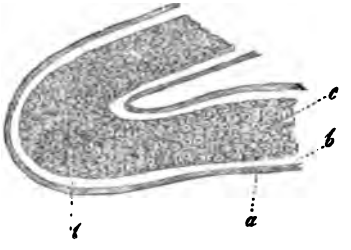
Fig. 712. A sudoriparous gland, with its blood-vessels. *a*, proper gland; *b*, duct; *c*, blood-vessels of a gland Magnified 35 diameters.

Fig. 713. Portion of the tube forming a sudoriparous gland from the hand. *a*, areolar coat; *b*, epithelium; *c*, cavity. Magnified 350 diameters.

into a knot near the closed end, which is situated in the subcutaneous cellular tissue, and forms the gland proper, and a straight, undulate or spiral duct, which traverses the skin perpendicularly, to terminate upon its surface between the papillæ.

In the glands of the axilla, the portion of the tube forming the gland proper is branched; and sometimes the branches anastomose.

Fig. 714.



Portion of a tube with a muscular coat, from the scrotum. *a*, connective tissue; *b*, muscular layer; *c*, epithelial cells, filling the tube and containing yellow granules. Magnified 350 diameters.

The coiled portion or proper gland is surrounded and permeated by an elegant plexus of capillaries; and some of them are surrounded by a capsule of connective tissue with spindle-shaped cells.

The tube of the glands exhibits two forms of structure. In one of these there is an outer coat of indistinctly fibrous connective tissue with elongated nuclei, sharply defined internally by probably a basement membrane, this being lined with one, two, or more layers of polygonal pavement-epithelial cells, mostly containing fat-globules and pigment-granules.

In the other form, the fibrillation of the connective coat is tolerably distinct, the fibres longitudinal, sometimes also with an inner, delicate transverse layer, and both containing nuclear elastic fibres; and within this coat is a layer of longitudinal, unstriped muscular fibres.

The portion of the ducts traversing the cuticle is spiral.

It is by no means an easy matter to obtain the sudoriparous glands in the entire state. The skin of the palm of the hand or the paw of a dog is best for the purpose; and before making sections with a Valentin's knife, the structure should be macerated in a mixture of 1 part nitric acid and 2 of water, or in solution of carbonate of potash.

Bibl. Kölliker, *Mik. An.* ii.; Todd and Bowman, *Phys. An.*; Biesiadecki, *Stricker's Hist.* ii. 238.

SUGAR.—This substance is liable to fraudulent adulterations; and the coarser kinds of brown sugar contain many impurities, such as Acari, fragments of the cane, &c. Starch and flour are used to whiten and give dryness to inferior moist sugar; and these may be detected by the microscope (Starch).

The crystals of sugar of milk are represented in Pl. 10. fig. 12; and those of diabetic sugar in fig. 13. (Hassall, *Food &c.* 12; and the Bibl. of Chemistry.)

SURIREL'LA, Turpin.—A genus of Diatomaceæ.

Char. Frustules free, single, ovate, elliptical, oblong, cuneate or broadly linear in front view; valves with a longitudinal median line or a clear space, the margins winged, and with transverse or slightly radiating canaliculi or tubular striæ.

It appears that in the valves the margins of the depressions are fused together to form tubular channels open at the ends.

S. bifrons (Ehr. 1833 = *S. biseriata*, Bréb. and Smith) (Pl. 17. fig. 22). Frustules in front view broadly linear, with rounded angles; valves elliptic-lanceolate, somewhat obtuse; alæ and canaliculi distinct; freshwater; length 1-180 to 1-96″.

S. gemma (Pl. 17. fig. 21). Frustules ovate; valves elliptic-ovate; canaliculi narrow, inequidistant; marine; length 1-240″.

S. splendida. Frustules ovato-cuneate, ends rounded; valves ovato-lanceolate; alæ and canaliculi distinct; freshwater; length 1-100″.

Bibl. Smith, *Br. Diatom.* i. 30; Kütz. *Bac.* 59, and *Sp. Alg.* 34; Rabenht. *Alg.* i. 51.

SWARMING.—This term has been applied, from comparison with the swarming of bees, to the remarkable oscillating crowding movements of the spores of Confervæ &c. while free in the cavity of the parent cell and preparing to break forth.

The spores are hence often called "swarming-spores." See Hydrodictyon.

SYCAMI'NA, v. Tieg.—A genus of Volvocineæ, composed of very minute spherical, biciliated cells, associated in large numbers to form a mulberry-like revolving mass, the protoplasm being black or brown, sometimes violet or reddish. *S. nigrescens*, found at the bottom of ponds and aquaria, forming a dark deposit, and producing the

decomposition of the organic matter. Reproduction by fission, and formation of resting spores. (V. Tieghem, *Bull. Soc. Bot. Fr.* 1880, 673; *Jn. Mic. Soc.* 1881, i. 97.)

SYENITE. See ROCKS.

SYMBIOTES = CHORIOPTES.

SYMBOLOPH'ORA, Ehr.—A genus of Diatomaceæ.

Char. Frustules single, disk-shaped, with incomplete septa radiating from the solid angular centre, and intermediate bundles of radiating lines. Marine and fossil.

S. Trinitatis (Pl. 25. fig. 6). Valves with a triangular umbilicus, the transparent margins of which are crenulate, the rest of the disk covered with six bundles of very fine radiating lines. Diameter 1-230". America.

S. acuta (Pl. 18. fig. 54); *S. micrasterias* (fig. 55); *S. pentas* (fig. 56).

BIBL. Ehr. *Ber. Berl. Ak.* 1844, 74; Kütz. *Sp. Alg.* 131.

SYMPHYOSI'PHON, Kütz. = *Scytonema* pt.

SYM'PLOCA, Kütz.—A genus of Oscillatoriaceæ (Confervoid Algæ), perhaps not distinct from *Symphyosiphon*.

SYNALIS'SA.—A genus of Collemei (Collemaceous Lichens), somewhat resembling *Lichina*, but with open apothecia. (Leighton, *Lich. Fl.* 13.)

SYNAP'TA, Eschsch.—A genus of vermiform Echinodermata.

The species of *Synapta*, which are not British, are of special microscopic interest, on account of the presence in their skin of remarkable anchor-shaped calcareous spicula, the bases of which play in perforated plates. These are situated upon minute papillæ of the skin, and serve to aid in locomotion and adhesion.

BIBL. V. d. Hoeven, *Zool.* i. 150; Vogt, *Zool. Briefe*, i. 168; Quatrefages, *Ann. Sc. N.* 2. xvii. 19; Gegenbaur, *Vergl. An.* 216; Herapath, *Qu. Mic. Jn.* 1865, 1.

SYNCHÆ'TA, Ehr.—A genus of Rotatoria, of the family Hydatinæa.

Char. Eye single, cervical, rotatory organ furnished with styles; foot forked; jaws each with a single tooth.

Some of the species are furnished with one or more so-called crests, which in some appear to correspond to the calcar.

S. baltica (Pl. 44. fig. 26). Body ovate; rotatory lobes four; styles four; a single median sessile crest; marine; length 1-108". Phosphorescent. Three other species. (Ehr. *Infus.* 436.)

SYNCHIT'RIUM, De By. & Woronin.—A genus of parasitic Unicellular Algæ, allied to CHYTRIDIUM, found under the epidermis of the leaves of *Taraxacum* and *Succisa*, and composed of aggregated orange-yellow cells, enclosed in an envelope, forming sori.

BIBL. Rabenht. *Alg.* iii. 284.

SYNCORY'NE, Ehr. (*pars*).—A genus of Corynidæ (Hydroida).

BIBL. Allman, *Ann. N. H.* 1864; Hincks, *Hyd. Zooph.* 48.

SYNCRYP'TA, Ehr.—A doubtful genus of Volvocineæ (Confervoid Algæ), composed of organisms consisting of a hyaline spherical gelatinous envelope, enclosing a number of ovate green bodies placed at the periphery, and sending out a pair of free vibratile cilia from the surface of the envelope. Green bodies not attenuated at the posterior extremity; no eye-spot. *S. Volvox* (Pl. 7. fig. 14 *b*), globe 1-576" in diameter, bodies 1-2880" long; freshwater. This object, which we have observed in company with those represented in figs. 14 *a*, 31 and 32 of the same plate, is most probably a young specimen of either *Volvox* or *Pandorina*. Kent places it among the Flagelliform Infusoria.

BIBL. Ehr. *Inf.* 60; Kent, *Inf.* 413.

SYNCYC'LIA, Ehr.—A genus of Diatomaceæ.

Char. Frustules cymbelliform, united in circular bands, immersed in an amorphous gelatinous substance. Marine.

The nodules appear to be the same as those of *Cymbella*.

S. salpa (Pl. 19. fig. 14). Frustules semiovate, unstriated (ord. illum.), commonly six together, united into a ring; endochrome bright green.

S. quaternaria. Frustules two or four together; endochrome yellow or reddish; length 1-860".

BIBL. Ehr. *Inf.* 233; *Ber. Berl. Ak.* 1840, 32; Kützing, *Sp. Alg.* 61; Rabenht. *Alg.* i. 97.

SYNDEN'DRIUM, Ehr. — A genus of Diatomaceæ.

Char. Frustules single, subquadrangular, destitute of a median umbilicus; valves unequal, slightly turgid—one smooth, the other with numerous spines or little horns branched at the ends, situated upon the median flat portion, the margins being free from them.

S. diadema (Pl. 18. fig. 59). Frustules lanceolate; spines five or six, bifurcate or

tufted at the end, as long as the frustules are broad. Breadth 1-1150″. Found in Peruvian guano.

Bibl. Ehr. *Ber. Berl. Akad.* 1845, 155; Kütz. *Sp. Alg.* 141; Pritchard, *Infus.* 866.

SYNECHOCOC'CUS, Näg.—A genus of Unicellular Algæ.

Char. Cells minute, oblong, single or conjoined in rows of 2–4; dividing in one direction only; endochrome æruginous or yellowish.

S. æruginosus (Pl. 3. fig. 26). Common on damp rocks and banks. (Rabenht. *Alg.* ii. 59.)

SYNE'DRA, Ehr.—A genus of Diatomaceæ.

Char. Frustules prismatic, rectangular, or curved; at first attached to a gelatinous, sometimes lobed cushion, subsequently often becoming free; valves linear or lanceolate.

The valves usually exhibit a longitudinal line, with a dilated median and two terminal nodules; they are also generally covered with transverse striæ; in some species the median line and appearance of a median nodule correspond to a clear space, free from the transverse striæ.

Species very numerous.

S. radians, Sm. (*splendens*, K.) (Pl. 17. fig. 23 *a*, *b*, *c*). Frustules elongated, in front view dilated and truncate at the ends; valves gradually attenuated from the middle to the obtuse ends. Freshwater; common; length 1-70″. Frustules radiate upon the cushion.

S. fulgens (*Licmophora fulg.* K.) (Pl. 17. fig. 24). Frustules linear; valves slightly dilated in the middle and at the rounded ends, arranged in a fan-shaped manner upon the branched cushion. Marine; length 1-120″.

S. capitata (Pl. 17. fig. 25). Frustules linear, truncate, ends slightly dilated; valves linear, ends dilated into a triangular head. Freshwater; length 1-60″.

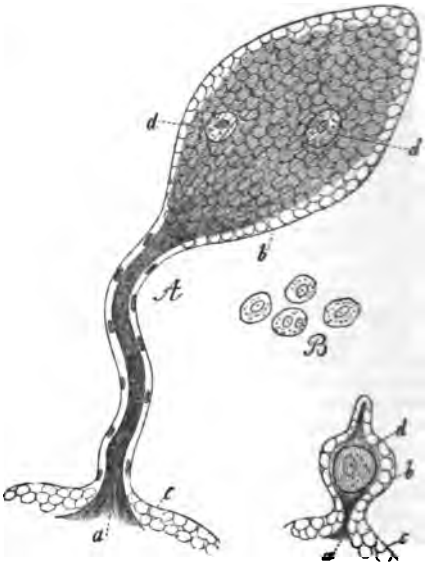
Bibl. Smith, *Br. Diat.* i. 69; Kütz. *Sp. Alg.* 40; Rabenht. *Alg.* i. 126; Grunow, *M. M. Jn.* xviii. 166.

SYN'GAMUS, Lieb.—A genus of Nematoid Entozoa. *S. trachealis* is very common in the trachea of poultry, producing the "gapes." (Dujardin, *Helminthes*, 260; Siebold, *Wiegmann's Arch.* 1835; Cobbold, *Paras.*)

SYNOVIAL MEMBRANES.—In minute structure these resemble serous membranes.

Synovial membranes are occasionally furnished with appendages, some of which contain fatty tissue, others abound in capillaries and form fringes where the synovial membrane is attached to the articular cartilages. The latter consist of a basis of indistinctly fibrous connective tissue, covered by the synovial epithelium, with a few fat-cells, sometimes isolated cartilage-cells, and the capillaries. Attached to their margins are flattened, conical, stalked, smaller appendages (fig. 715), seldom containing blood-vessels, and composed of indistinctly fibrous areolar tissue, with scattered cartilage-cells, and a thick epithelial layer; while some of the smaller ones consist almost entirely of epithelial cells or of areolar tissue.

Fig. 715.



From he synovial membrane of a finger-joint.

A. Two appendages of the synovial processes. *a*, areolar tissue in its axis; *b*, epithelium of the free margin: *c*, that continuous with the epithelium of the processes; *d*, cartilage-cells. Magnified 250 diameters.

B. Four epithelial cells from the synovial membrane of the knee-joint, one of them with two nuclei. Magnified 350 diameters.

Bibl. Brinton, *Todd's Cycl. An. & Phys.* art. *Serous Membranes*; Albert, *Stricker's Hist.* iii.

SYN'TETHYS, Forbes.—A genus of Tunicate Mollusca, of the family Botryllidæ.

Char. Mass sessile, gelatinous, forming a single system; animal sessile, having simple

orifices, without rays. One species: *S. Hebridicus.*

BIBL. Gosse, *Mar. Zool.* ii. 34.

SYNU'RA, Ehr.—A doubtful genus of Volvocineæ (Confervoid Algæ), consisting of a number of oblong corpuscles attached together by their prolonged filiform posterior extremities to form a globe; flagella two; no eye-spot. In *S. Uvella* the corpuscles are yellowish, the tails three times as long as the bodies; diameter of globes 1-290″. See VOLVOX. (Ehr. *Inf.* 6; Kent, *Inf.* 411.)

SYRINGIDIUM, Ehr.—A genus of Diatomaceæ.

Char. Frustules single, terete; valves acuminate at one end, two-horned at the other. Marine.

S. bicorne (Pl. 18. fig. 32). Frustules oblong, smooth, not striated, turgid in the middle, one end attenuate, with two slight constrictions, and acuminate, the other subglobose, turgid, and with two horns. Length 1-370″. Coast of Africa.

S. palæmon (Pl. 18. fig. 33).

BIBL. Ehr. *Ber. Berl. Ak* 1845, 365; Kütz. *Sp. Alg.* 32; Pritchard, *Inf.* 866.

SYRINGOSPHÆ'RIDÆ, Duncan.—An extinct Order of Rhizopoda. Free, globular, sometimes 3″ in diameter, consisting of congeries of tubes (1-1000 to 1-300 inch), in radial groups, with an interradial reticulation of inosculating tubes, some of which appear at the surface. *Syringosphæra*, 5 species, and *Stoliczkaria*, 1 species, Triassic (?), N. India, known as "Karakoram Stones."

BIBL. Duncan, *Ann. N. H.* 5. ii. 297; *Yarkand Miss.* 1879; *Qu. J. Geol. S.* xxxviii. 69.

SYSTEPHA'NIA, Ehr.—A genus of Diatomaceæ.

Char. Frustules circular; valves alike, areolar, neither radiate nor septate, with a crown of spines or an erect membrane on the outer surface of each valve (not on the margin). Fossil.

S. corona (Pl. 18. fig. 57); *S. diadema* (fig. 58).

One other species; found in Bermuda.

BIBL. Ehr. *Ber. Berl. Ak.* 1844, 264; Kütz. *Sp. Alg.* 126; Pritchard, *Infus.* 832.

SYZYGI'TES, Ehrenberg (see PHYCOMYCES).—A genus of Mucorini (Phycomycetous Fungi), containing two species, a kind of mould growing over decaying Agarics, remarkable among all the class to which they belong for the occurrence of the phenomenon of conjugation of the branches as a preliminary to the formation of the spores. Ehrenberg discovered the conjugation in *S. megalocarpus* many years ago. The young filaments are simple, slender, rather rigid, pellucid and straight,—soon becoming forked, thickish, whitish yellow (somewhat olive when dry). The rudiments of the peridioles spring out as papillæ from the branches, becoming pear-shaped; and when two come into contact, they cohere, and become confluent into a fusiform body. The contents of the filaments next ascend and accumulate in the peridiole, at length forming a black globule (sporange?). While this is ripening, the apices grow out into long simple filaments.

Fig. 716.

Syzygites megalocarpus.
A branched filament, exhibiting the conjugation in various stages.
Magnified 200 diameters.

BIBL. Ehrenb. *Verhandl. Naturf. Freund.* Berlin, i. p. 91; Fries, *Syst. Myc.* iii. p. 329; Berkeley, *Ann. Nat. Hist.* i. p. 259; Van Tiegh. *Ann. d. Sci. Nat.* 1873.

T.

TABELLARIA, Ehr.—A genus of Diatomaceæ.

Char. Frustules tabular, attached, at first united into a filament, subsequently cohering only by the angles, with longitudinal vittæ interrupted in the middle; valves inflated in the middle and at each end, striated; freshwater.

T. flocculosa (Pl. 17. fig. 27 *a*, *b*). Septa 3–5 on each margin. Length 1-960 to 1-840″.

T. fenestrata. Frustules oblong; vittæ two, opposite. Length 1-600 to 1-290″.

Five fossil species.

BIBL. Kütz. *Sp. Alg.* 118; Smith, *Br. Diat.* ii. 44; Pritchard, *Infus.* 807.

TACHID'IUS, Lillj.—A genus of Copepodous Entomostraca. *T. brevicornis*; marine. (Brady, *Copep.* ii. 19.)

TACHYGO'NIUM, Näg.—A doubtful genus of Palmellaceæ. (Rabenh. *Alg.* iii. 36.)

TADPOLE. See FROG.

TÆNIA (Tape-worm).—A genus of Cestoid Entozoa.

Char. Body elongate, compressed, jointed. Head mostly broader than the very narrow neck, with four suctorial depressions; and usually a median, imperforate retractile rostellum, very frequently armed with one or two circles of minute recurved hooks, especially in the young state. Genital orifices situated at the margins of the joints or proglottides, either on one side only, or on both margins and on alternate joints.

The *Tæniæ*, of which the common tape-worm may be taken as the type, are found in vertebrate animals alone, and in these only in the alimentary canal. They are most common in birds, next in mammalia, then in fishes, and lastly in reptiles.

The species are very numerous: Rudolphi enumerated 146; Dujardin 135.

Tænia solium, the common human English species, varies in breadth from 1-50 to 1-40″ at the anterior part, to about 1-3″ at the middle and posterior part. At the anterior extremity is situated a central rostellum, which is surrounded by a crown of small recurved hooks, as in Pl. 21. figs. 1 *f* & 10. Behind these are four suctorial depressions, which are not pervious at the bottom. The digestive system is wanting, and the worm absorbs by its surface; but according to Blanchard, it is represented by two tubes or lateral canals (Pl. 21. fig. 14 *a*), having between them a transverse canal at the summit of each joint; these extend from the anterior to the posterior end of the body. In the cephalic portion, directly behind the suckers, there is a kind of lacuna or furrow communicating directly with these intestinal tubes; and it appears that the nutritive matters respired by means of the suckers penetrate into this lacuna, and thence into the digestive canals. These tubes have distinct walls, and are best seen when the animal has been macerated in water, and is examined by transmitted light, or after having been injected. But this is very doubtful.

The vascular system, according to the above author, consists of four longitudinal vessels (Pl. 21. fig. 14 *b*) situated a little above the intestinal tubes, and infinitely more slender. They traverse the whole length of the body; and between them are numerous transverse vessels (Pl. 21. fig. 14). These so-called digestive and vascular canals are now considered as belonging to a water-vessel system; the canals unite in the last segment in a receptacle.

The male generative organ consists of a slender coiled tube, extending to near the principal ovigerous canal, where it is preceded by some very small testicular capsules (Pl. 21. fig. 14 *c*). The slender tube terminates in a duct (fig. 14 *d*), which opens into the lateral orifice, or sometimes it projects externally in the form of a spiculum. The ovary consists of a principal median canal, presenting slight flexuosities, and extending nearly from one end to the other of each joint. It presents cæcal branches on both sides, and opens by a slender oviduct (fig. 14 *e*) just within the genital orifice.

The ova are innumerable; one is figured in Pl. 21. fig. 15. They consist of an outer delicate membrane, enclosing a gelatinous substance containing numerous highly refractive globules. Within this is another very delicate and transparent membrane, closely applied upon a brittle, dark-looking (by transmitted light, but white by reflected light), thick envelope, within which is the yolk or embryo, according to the state of development of the ovum. Very frequently the hooks of the young tænia are seen imbedded in its centre, as shown in the figure. The thick brittle coat of the ovum exhibits an appearance of radiating fibres (canals?); and when broken, the fractures are radiant. When the middle of the outer surface of the brittle envelope is brought into focus, it presents a tolerably regular appearance, as if composed of cells; this arises, however, from the extremities of the fibres being brought into focus.

The filiform spermatozoa are readily found, simply by picking any joint containing ova to pieces with needles.

The young animal, consisting of head and neck only, was formerly considered distinct, and placed in a genus (*Scolex*).

Among other species may be mentioned: *Tænia mediocanellata*, the unarmed tape-worm of the ox; *T. crassicollis*, in the cat; *T. echinococcus*, in the dog and wolf; *T. serrata*, in the dog; and *T. nana*, human, in Egypt.

The old genera *Cœnurus*, *Cysticercus*, and *Echinococcus* are the larval or nurse-forms of *Tænia*.

Bibl. Weinland, *on Tape-worms*; Sommer, *Geschlechtsorg. v. T. sol. & mediocanellata*; Mégnin, *Compt. rend.* 1879, 88, *Ann. N. H.* 1879, iii. 317; Pintner, *Bau &c.* 1880; Moniez, *Cestodes*, 1881; Stein, *Entwick. u. Parasitism. menschl. Cestoden*, 1882.

TÆNITIS, Sw.—A genus of Grammitideæ (Polypodiaceous Ferns). Five species; tropical. (Hooker, *Syn.* 396.)

TALC. See Mica.

TAO'NIA, J. Ag.—A genus of Dictyotaceæ (Algæ), containing one rare British species, *T. atomaria*, which has a flat, membranous, fan-shaped, deeply cleft frond, 3 to 12″ high, of brownish olive colour; marked on both faces, at intervals of 1-4 to 1-2″, with concentric wavy lines, formed by rather crowded dark-brown "spores," the interspaces being dotted over with scattered spores. The disk of attachment is covered with woolly filaments.

Bibl. Harvey, *Mar. Alg.* 38; Thuret, *Ann. Sc. N.* 4. iii. 7.

TAPHRI'NA.—A very low form of Ascomycetous Fungi, formerly included under Erineum, to which genus *E. aureum*, on Poplar, and *E. clandestinum*, on Hawthorn, are now referable. (Tulasne, *Ann. d. Sc. N.* sér. v.; Greville, *Crypt. Fl.*)

TAPHROCAM'PA, Gosse.—A genus of Rotatoria, of the family Hydatinæa.

Char. Rotatory organs absent; body fusiform, annulose, tail forked, gizzard oval.

T. annulosa. Freshwater; length 1-110″.

Bibl. Gosse, *Ann. N. H.* 1851, viii. 199; Pritchard, *Inf.* 692.

TAPIOCA.—A very pure fecula prepared from the finer particles of the starch of the Mandioc or Cassava plant (Pl. 46. fig. 14). The starch-granules of tapioca of the shops appear to have undergone the action of heat, which disguises the characters. See Starch.

TARDIG'RADA (Water-bears).—An Order of Arachnida.

These microscopic animals are found in stagnant fresh water, amongst water-plants, in patches of wet moss, in the gutters of houses, &c.

Body soft, cylindrical or elongate-oval in outline, with four transverse furrows or indistinct segments, and a fifth anterior, corresponding to a head, short, conical, retractile and with indications of two or three segments; sometimes dilated at the end to form a sucker, or furnished with unequal, short, palp-like processes. Eyes two.

The oral organs are represented by a tubular rostrum, through the sides of which, from without inwards, two calcareous styles or mandibles pass, and serve to wound the animals forming their prey. At the base of the rostrum is a gizzard with radiating muscular fibres, in *Macrobiotus* enclosing a kind of framework consisting of six parallel jointed cylinders.

The alimentary canal is straight, and furnished with lateral cæcal appendages. The ovary is a simple sac, behind which is situated a seminal vesicle containing spermatozoa, both opening into a cloaca. But few eggs are produced at a time; they are either smooth, rugose, or studded with points, and are usually deposited during the ecdysis, the exuviæ serving as a protection to them during the process of hatching. The young resemble the parents.

The Tardigrada resemble some of the Rotatoria in reviving after having been kept dried for years.

Genera: *Emydium*, *Macrobiotus*, *Milnesium* (*Arctiscon*, doubtful).

Bibl. Doyère, *Ann. Sc. Nat.* 2. xiv. 269, xvii. 193, xviii. 1; Dujardin, x. 185; Vogt, *Zool. Briefe*, i. 496; Kauffmann, *Sieb. und Köll. Zeitschr.* iii. 220; Greef, *Schultze's Archiv*, i. 101; Lubbock, *Metam. of Insects.*

TARGIO'NIA, Mich.—A genus of Pelliæ (Hepaticæ), characterized by the almost sessile globose capsule arising from the end of the midrib of the under face of the frond, which is somewhat fleshy, smooth, deep-green, purplish at the edges, and forms large patches on rather moist but exposed banks. The frond has an epidermis on both faces, with stomata and intermediate parenchyma; the midrib is only apparent beneath, and has radical hairs, with purple scales. The perichæte originates from this rib, on the under surface, rising to the upper side (fig. 717). When mature, it is globose, of dark purplish colour and firm texture, and marked with a vertical prominent line or keel: at this line it ultimately splits into two valves (fig. 718). Hofmeister's observations, however, show that this envelope grows up after the fertilization of the archegone, which is originally naked in its upper half; hence it would seem to be a *perigone*. Several archegones are found half-immersed in the end of the midrib; and one of these is converted into a fruit; the lower part becomes spherical, and the neck forms for a

Fig. 717.

Fig. 718.

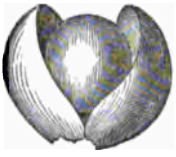


Fig. 719.

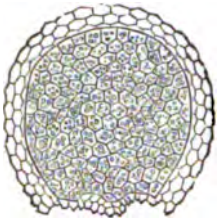
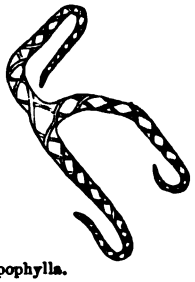


Fig. 720.



Targionia hypophylla.

Fig. 717. Lobe of a frond with fruit. Magnified 5 diameters.

Fig. 718. Perichæte opened, showing the globular sporange. Magnified 20 diameters.

Fig. 719. Vertical section of a very young sporange. Magnified 200 diameters.

Fig. 720. A branched elater. Magnified 200 diameters.

Fig. 721.

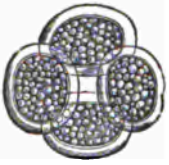


Fig. 722.

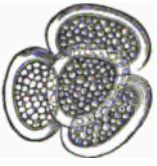


Fig. 723.

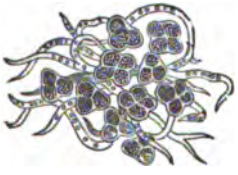


Fig. 724.

Fig. 725.

Figs. 721 & 722. Groups of four spores, not quite mature. Magnified 400 diameters.

Fig. 723. Parent cells of spores and imperfect elaters, from a more advanced fruit. Magnified 100 diameters.

Fig. 724. The same. Magnified 200 diameters.

Fig. 725. A single ripe spore. Magnified 400 diameters.

long time a filiform point or style. This epigone bursts irregularly and vertically. The spherical capsule emerges from it, but is not protrnded beyond the perichæte. The globular capsule bursts irregularly at the summit, and discharges spores and elaters resembling those of *Marchantia* (figs. 723 to 725). The antheridia are imbedded in the midrib, opening on papillæ on the lower face.

Bibl. Hook. *Brit. Flor.* ii. pt. 2. p. 105; Corda, *Sturm's Deutschl. Fl. Jungerm.* pl. 26; Nees, *Lebermoose*, iv.

TARTARIC ACID.—The crystals of this substance, which belong to the oblique-prismatic system, exhibit beautiful colours under the polariscope. A concentrated aqueous solution is useful in the chloride-of-gold staining process.

TAYLO'RIA, Hk.—A genus of Splachnaceæ (Acrocarpous Mosses). *T. serrata* (fig. 474, p. 512), on Scotch mountains. (Wilson, *Bry. Brit.* 283.)

TAXUS, L.—*Taxus baccata* is the Yew tree, belonging to the Coniferæ. Its wood (Pl. 48. fig. 4), as also that of *T. canadensis*, shows the remarkable combination of spiral fibres with the coniferous pits. Its embryology is also interesting. See Coniferæ and Ovule.

TEA (the prepared leaves of *Thea viridis* and *T. Bohea*, Nat. Ord. Ternstrœmiaceæ).—This important article of commerce has afforded some of the most remarkable examples of systematic fraud, practised not merely by the vendors in this country, but by the Chinese manufacturers. The principal adulterations of tea consist of re-manufactured exhausted tea-leaves, spurious tea made up of the dust of tea and other leaves, together with earthy matter, by the aid of gum, and of spurious tea made of leaves of other plants,—the whole of these being prepared either for black or green tea by 'facing,' or imparting a colour or bloom with black-lead, indigo, prussian blue, mica, turmeric, &c.

The leaves of tea may be distinguished when moistened and spread out, and still more decidedly, even in fragments, by the aid of the microscope, which shows the peculiarities of the epidermis of the upper or lower faces, &c. (Pl. 2. fig. 1). Other leaves fraudulently introduced may be thus separated, and often identified by careful comparison with known kinds likely to have been employed. The spurious tea made up of agglutinated rubbish falls to pieces instead of unrolling when infused

with hot water. The 'facing' of the various kinds is mostly distinguishable with a common lens, and when the tea is infused forms a sediment, the characters of which may be determined by the microscope and by chemical analysis.

Bibl. Hassall, *Food &c.*, 268; Warington, *Tr. Chem. Soc.* 1851.

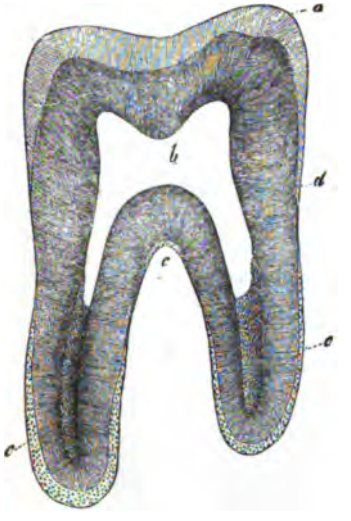
TEETH.—The teeth of the Mammalia are inserted in sockets or alveolar cavities of the jaws.

The teeth consist of:—a crown, or that portion which projects beyond the alveolar cavity and the gum; the fangs, or the portions which are inserted into the bony structures; and a neck, or narrower intermediate portion. The crown of the tooth contains the pulp-cavity, which is closed above, but prolonged below through the fangs.

In regard to their structure, teeth are in part identical with bone, in part closely allied to it; but in respect to their development, they must be regarded as formations of the mucous membrane, as modified papillæ.

The substance of human teeth consists of three parts:—the ivory or dentine (fig. 726 *d*),

Fig. 726.



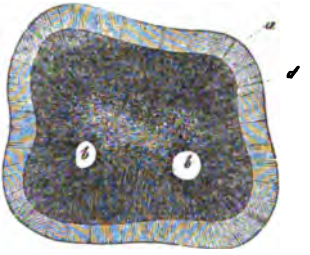
Molar tooth, human: longitudinal section.

a, enamel; *b*, pulp-cavity; *c*, cement; *d*, ivory, with the ivory-tubes. Magnified 5 diameters.

which constitutes the greater portion of their mass, and to which their form is mainly owing; the cement, or bony portion (fig. 726 *c*), which forms an external covering, principally of the fangs; and the enamel (fig. 726 *a*), which covers the crown.

The *ivory* or *dentine* (figs. 726 *d*, 727 *d*) is whitish and of a silky lustre, and, excepting a small portion at the base of the fangs, forms the entire boundary of the cavity of the teeth. It consists of a homogeneous

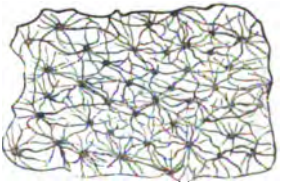
Fig. 727.



Transverse section of the same; the references as above. Magnified 5 diameters.

matrix enveloping numerous tubes or canaliculi, called the ivory-tubes (fig. 729 *a*, *b*). The tubes are very fine, and pursue an undulating course, at first curving, then bifurcating, throughout giving off numerous fine lateral communicating branches, which are best seen in a horizontal section (fig. 728), and ultimately ramifying and anastomosing freely. They commence at the surface of the pulp-cavity, in the crown following a somewhat radiating direction from its centre (fig. 726), whilst in the fangs their course is more horizontal. They have distinct

Fig. 728.



Transverse section of the ivory-tubes of the fang (*a*), fig. 729), showing their numerous anastomoses. Magnified 450 diameters.

walls, about equal in thickness to their calibre, although in transverse sections (fig. 730) this thickness is generally exaggerated, on account of their being obliquely divided. They contain air in the dry state, which

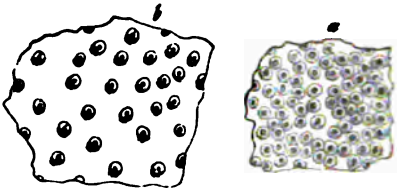
may be displaced by liquids. By removing the inorganic salts from a tooth with dilute

Fig. 729.

Ivory-tubes of a fang of a human tooth. *a*, inner surface of the ivory, with few tubes; *b*, their branches; *c*, their terminations in loops; *d*, granular layer, consisting of small ivory globules at the boundary of the ivory; *e*, lacunæ of bone, one anastomosing with an ivory-tube. Magnified 50 diameters.

muriatic acid, and macerating the remaining cartilage with acids or caustic alkalies until it forms a pasty mass, the tubes may be isolated from the basis.

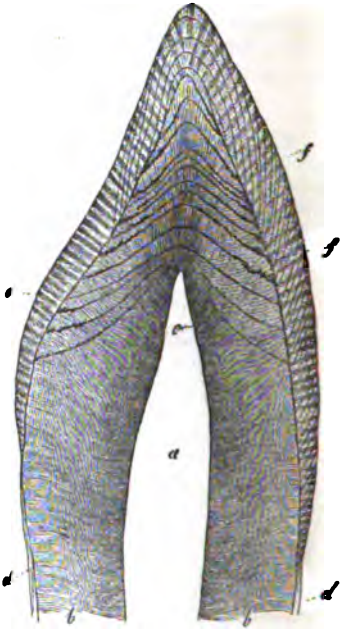
Fig. 730.



Transverse section of the ivory-tubes. *a*, closely aggregated; *b*, wider apart. Magnified 450 diameters.

In sections made from fresh teeth, high powers of the microscope (500 or 1000 diameters) being used, it is not difficult to recognize, especially in the centre of the

Fig. 731.

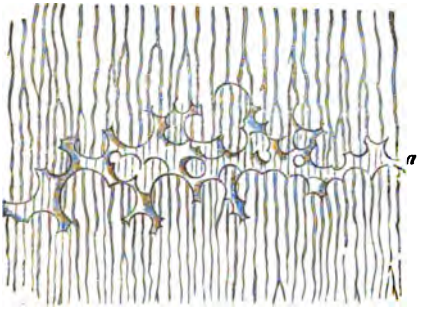


Perpendicular section of the apex of a human incisor tooth. *a*, pulp-cavity; *b*, ivory; *c*, curved contour lines with interglobular spaces; *d*, cement; *e*, enamel, with indications of the course of the fibres in various directions; *f*, coloured stripes of the enamel.
Magnified 7 diameters.

tooth, the fine, pale, homogeneous processes of the tooth-pulp or dentine-fibres. These may be stained by carmine.

The ivory not unfrequently exhibits indications of a laminated structure, forming,

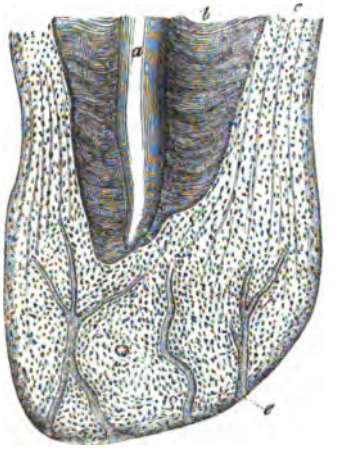
Fig. 732.



Portion of the ivory, with ivory-globules and interglobular spaces filled with air. Magnified 350 diams.

in longitudinal sections, curved lines more or less parallel to the outline of the crown (fig. 731), appearing as rings in transverse sections, and called the *contour-lines*.

Fig. 733.



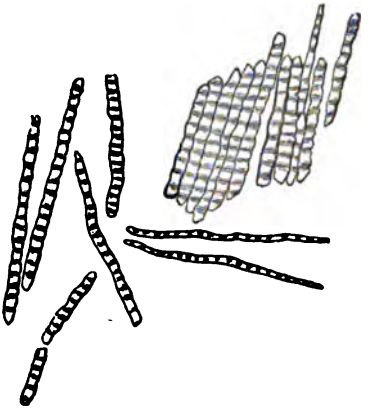
Cement and ivory of the fang of a tooth of an old person. *a*, cavity; *b*, ivory; *c*, cement with lacunæ; *e*, Haversian canals. Magnified 30 diameters.

Near the enamel (fig. 731) and the cement (fig. 729 *d*) also, the ivory presents one or more irregular dark patches or bands, often continuous with the ends of the contour-lines, and exhibiting a coarsely cellular appearance. On careful examination, the dark appearance is seen to result from a number of irregular spaces filled with air (fig. 732 *a*) intervening between certain globules, called *ivory-globules*, the spaces being termed the *interglobular spaces*. In the recent tooth, these spaces are filled with the organic basis of the ivory, containing tubes like the rest of that substance, in which, however, the inorganic matter has not been deposited; hence this structure arises from imperfect development.

Other, ill-defined iridescent stripes, running parallel to the pulp-cavity, are sometimes seen; these correspond to the primary curves of the ivory-tubes.

The *cement* or bone of teeth forms the outer coating of the fangs (figs. 726 & 733, *c*),

Fig. 734.



Enamel-fibres, isolated by the very slight action of muriatic acid; human. Magnified 30 diameters.

sometimes cementing them together. It commences as a very thin layer at the part where the enamel ceases, increasing in thickness towards the ends of the fangs. The cement does not differ from bone in structure, except in rarely containing Haversian canals. In the molar teeth of old persons, however, these are met with (fig. 733 *e*). The lacunæ are frequently absent from the thinner portion of the cement; and it sometimes contains tubes like those of the ivory. The interlacunar substance is sometimes striated, and exhibits a laminated structure.

The *enamel* (fig. 726 *a*) covers the ivory

of the crown of the teeth. It is thickest at the opposing surface, decreasing towards the neck, where it terminates. The *cuticula* is an extremely resistant investment to the exposed portions of the teeth, and which disappears when they are mature. It is separable after the action of muriatic acid, and may be tinted with a solution of nitrate of silver, which causes the appearance of figures like large epithelial cells. The enamel has a fibrous aspect, and appears of a bluish-white colour by reflected light, and of a greyish brown by transmitted light. It is very brittle, and so hard as to strike fire with steel. It consists of numerous solid fibres or prisms (fig. 734), about 1-6000 to 1-5000″ in breadth, mostly six-sided, more or less wavy, slightly varicose, and transversely striped. These usually extend throughout the thickness of the enamel, and are placed in a direction generally perpendicular to the surface of the portions of the ivory which they cover (figs. 726, 731). The form of the fibres is best seen by viewing their ends in a transverse section (fig. 735). The prisms do not

Fig. 735.

Fig. 736.

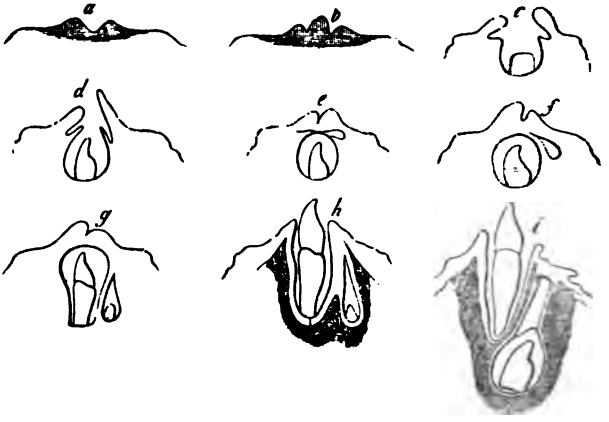


Fig. 735. Surface of the enamel, with the ends of the enamel-fibres, from the tooth of a calf. Magnified 350 diameters.

Fig. 736. Diagram showing the development of a milk-tooth, and the corresponding permanent tooth. *a*, furrow; *b*, the same with the papilla; *c*, the same closing, with the commencement of the reserve cavity; *d*, the same, further closing; *e*, follicle completely formed, with the reserve cavity; *f*, the reserve cavity receding; *g*, the same, with a tooth-germ; *h*, the alveoli of both capsules formed, the milk-tooth being through the gum; *i*, the same further advanced, the neck of the capsule forming a solid cord.

run exactly parallel with each other, but are arranged in groups or zones, the fibres of which cross each other. The fibres are readily isolated before they have become so developed as to be hard, and when very slightly acted upon by muriatic acid. It is doubtful if sometimes the ivory-tubes extend into the enamel.

Two kinds of dark bands or stripes are seen traversing the enamel (fig. 731). The direction of one of these coincides pretty nearly with that of the fibres, and it arises from the crossing of the zones of fibres, allowing more or less light to pass through, the bands being light and dark. The other set (fig. 731, *ff*) consists of arched, brownish stripes, indicating the laminated structure of the enamel. Under the polariscope, a third set becomes visible, arising from the variable inclination of the axes of the fibres to the plane of polarization.

The enamel is often traversed by cracks, mostly running parallel with the fibres, and containing air in dry teeth.

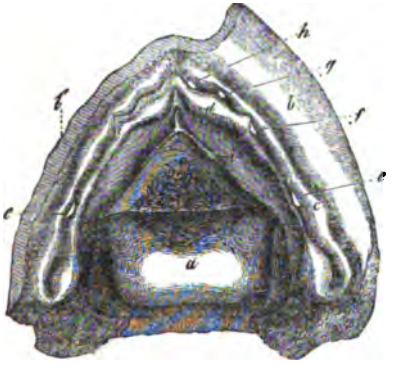
Pulp.—The pulp of the teeth is the vascular and nervous matrix of the dentine and the remains of the original tooth-papilla. It contains a few blood-vessels and nerves, being connected with the periosteum and base of the sockets of the jaw. The principal part is made of indistinctly fibrous connective tissue, containing numerous cells; and it appears to be quite cavernous from the breaking up of the terminal capillaries.

The external layer is formed of large cells of elongated form, provided with numerous processes called odontoblasts, which are arranged so as to form a kind of columnar epithelium. They are finely granular, but have no cell-wall. Three kinds of processes may be distinguished in these cells—the dentinal, pulp, and lateral processes. The dentinal processes become the beforementioned dentinal fibres of the ivory.

Chemically, teeth consist of an organic, cartilaginous basis, agreeing in composition with that of bone, and of inorganic matter, consisting principally of phosphate of lime with a small quantity of the carbonate.

Development.—At the beginning of the third month, the margins of the jaw form a slight ridge, which consists of a thickening of the embryonic connective tissue and epithelium of the mucous membrane of the mouth. The rudiments or germs of the first (milk) teeth are met with in the sixth week of fœtal life, and consist of small papillæ, one for each tooth, which become visible in grooves of the mouth, afterwards forming

Fig. 737.



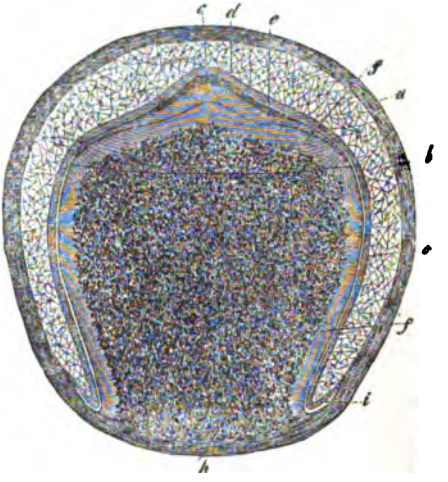
Lower jaw of a human nine weeks' fœtus. *a*, tongue, turned back; *b*, right half of the lower lip turned aside; *b'*, left half of the lip cut off: *c*, outer wall of the gum; *d*, inner wall of the gum; *e*, *f*, *g*, *h*, papillæ of the teeth; *i*, fold where the sublingual duct subsequently opens.

Magnified 9 diameters.

the alveolar processes. The epithelium forms the enamel, and the other tissue the dentine and cement. Processes from the sides of these dental grooves are then formed, and, approaching each other, enclose the papillæ in distinct follicles, the margins of which gradually grow over the papillæ, and uniting, convert them into closed sacs or capsules. The pulps then become moulded into the form of the future teeth, the bases of the pulps dividing into as many portions as the teeth have fangs; and as the capsules increase at this stage faster than the pulps, a space is left between them, in which a gelatinous-looking substance is deposited from the wall of the capsule forming the enamel-organ. By some recent authors, however, the existence of the dental grooves is denied.

The capsule (fig. 738 *a*) possesses a connective coat with vessels and nerves; and from its base arises the tooth-germ or pulp (fig. 738 *h*). The pulp consists of an outer

Fig. 738.



Capsule of the second incisor tooth of an eight months' human fœtus. *a*, capsule; *b*, enamel-pulp; *c*, enamel-membrane; *d*, enamel; *f*, ivory-cells; *h*, papilla of tooth or pulp; *i*, free margin of enamel-organ.

Magnified 30 diameters.

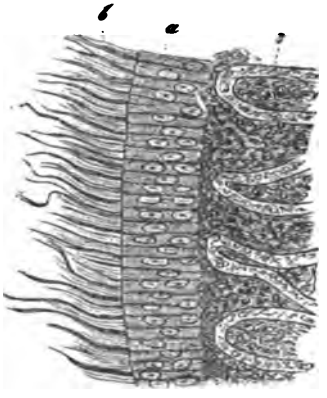
non-vascular layer of elongated nucleated cells, with filiform processes, in close apposition (fig. 739 *a*), covering the surface of the pulp—the ivory-membrane (fig. 738 *f*), not distinctly defined internally, but gradually passing into the vascular parenchyma of the pulp. The inner part of the pulp consists of indistinctly fibrous connective tissue with nuclei, the vessels terminating in loops beneath the enamel-membrane (fig. 739 *c*).

The enamel-organ (fig. 738 *b*) covers by its inner concave surface the pulp, its out-

side being in apposition with the capsule. It forms a spongy tissue, composed of anastomosing stellate cells or reticular areolar tissue; in its inside is the enamel-membrane, consisting of cylindrical epithelium (fig. 738 *c*).

The enamel is formed by the direct calcification of the epithelium, the prisms resulting from the calcification of the long cylindrical cells.

Fig. 739.



Surface of the pulp of a newly-born infant. *a*, ivory-cells; *b*, their appendages; *c*, vascular part of the pulp. Magnified 300 diameters.

Ossification commences by the deposition of calcareous matter in the cells of the ivory-membrane at the summit of the pulp; this is soon followed by similar deposition in the cells of the enamel-membrane. By the further formation of new cells and fresh deposition, the structure of the teeth becomes more and more consolidated, the spongy tissue of the enamel gradually being absorbed.

When the entire enamel and a considerable portion of the ivory have been formed in the capsules, these become too small to contain the teeth, which then rupture them, and continue to grow at the root, until the crown projects above the margin of the jaw. The remainder of the capsule then forms the periosteum of the alveoli, and, by deposition from the side next the tooth, produces the cement.

The permanent teeth are formed upon the same plan:—the three last molars in the remains of the primitive dental groove; the others in distinct sacs, called reserve sacs, and formed in the wall of the follicles of the milk-teeth.

The teeth of animals present numerous interesting varieties, to which we can but briefly refer. Thus, in the Mammalia the enamel is often absent, the cement frequently extends over the crown, the three component structures are folded, the teeth are compound, the ivory contains Haversian canals, and the ivory-tubes enter the enamel. In Reptiles the teeth are often anchylosed to the jaws. In Fishes the teeth are often solid; the ivory is furnished with Haversian canals, sometimes isolated, and each surrounded by a layer of ivory and cement, so that the teeth appear to consist of aggregations of little teeth; the vessels often branch and anastomose freely; the ivory-tubes are often very large or absent, the ivory then consisting of a finely granular base with numerous vascular canals, true enamel appearing to be absent.

The oral and gastric teeth of the Mollusca (see TONGUE), Vermes, and Arthropoda, are composed of chitine, which is sometimes impregnated with lime or silica. The teeth of Echinida are composed essentially of thin leaflets aggregated into a radial lamina; and they are composed of elongated prisms of carbonate of lime, somewhat curved at their extremities. These lustrous calcareous plates lie between the prisms, and present a fine plexus of anastomosing canaliculi.

It may be said generally that the teeth of the higher Invertebrata are to be regarded as epithelial structures, and that in the lowest Vertebrata they are chiefly composed of peculiarly modified and ossified connective tissue.

The method of making sections of teeth is described under PREPARATION. They should be very thin, and preserved in the dry state.

BIBL. Owen, *Odontography*, and *Todd's Cycl.* iv. 864; Goodsir, *Ed. Med. and Surg. Jn.* 1839, i.; Tomes, *Dental Surgery*, and *Phil. Tr.* 1849, 1850; Hanover, *Verh. Leopold. Carol. Ak.* xxv. 2, *Mic. Jn.* 1857, v. 166; Huxley, *Qu. Mic. Jn.* 1854, 1855, 1857; Lankester, *Qu. Mic. Jn.* 1867; Boll, *Zahnpulpa, Arch. Mik. An.* iv. 1868; Cutler, *Dental Comos*, 1867; Rolleston, *Qu. Mic. Jn.* 1872; Waldeyer, *Stricker's Hum. & Comp. Hist.* i.; White, *Mn. Mic. Jn.* vii. 263; Tomes, *M. M. Jn.* xiii. 85; Frey, *Hist.* and the *lit.*

TEGEOC'RANUS, Mich.—A new genus

of Oribatea (Michael, *Jn. Mic. Soc.* 1879, 247; 1880, 32, 177).

TELOTROCHID'IUM, Kt.—A genus of Peritrichous Infusoria. Free, ovate or campanulate, no tail; two ciliary rings; anal aperture posterior.

T. crateriforme; freshwater. (Kent, *Inf.* 643.)

TEM'ORA, Baird.—A genus of Copepodous Entomostraca, family Diaptomidæ.

Char. Thorax composed of five, abdomen of three joints; lesser antennæ two-branched; first four pairs of legs each giving off a two-jointed branch. *T. finmarchica.* On the British coasts. (Baird, *Br. Entomostr.* 227; Brady, *Cop.* i. 37.)

TENDON. See LIGAMENTS.

TENTHRE'DO, Leach.—A genus of Hymenopterous Insects, of the family Tenthredinidæ (Saw-flies).

The species of *Tenthredo* and of the other genera belonging to the family, both of which are very numerous, are interesting on account of the remarkable structure of the ovipositor, which consists of two flattened and curved saw-like plates. These are used to saw the leaves of plants, for the deposition of the eggs.

The insects are found upon gooseberry-bushes, rose-bushes, the white thorn, the willow, alder, poplar, the plum- and other fruit-trees, cabbage, turnip, bramble, &c. The larvæ are very destructive to agricultural crops.

T. nassata is represented in figure 366 (p. 437).

BIBL. Westwood, *Introduction*, ii. 90.

TEREBEL'LA.—A genus of Tubicolar Annulata.

The animal forms a tube of sand and portions of shell, agglutinated by a secretion. Carpenter remarks that in the respiratory organs situated in the part outside the tube —the head—two liquids may be seen circulating:—one colourless, containing numerous cell-like corpuscles, which can be seen in the smaller and more transparent species to occupy the space intervening between the outer surface of the alimentary canal and the inner wall of the body, and to pass from this into canals, which often ramify extensively in the respiratory organs, but are never furnished with a returning series of passages; while the second is a usually red liquid containing few particles, and enclosed in a system of proper vessels communicating with a central propelling organ. In *Terebella* a distinct provision is made for the aëration of both fluids; for the first is transmitted to the tendril-like tentacula which surround the mouth, whilst the second circulates through the beautiful arborescent branchiæ situated just behind the head. The former are covered with cilia, the action of which continually renews the water in contact with them, whilst the latter are destitute of them. The colourless liquid is probably blood, and the red belongs to the water-system.

BIBL. Huxley, *Comp. An.*; Carpenter, *Microscope.*

TERPSIN'OË, Ehr.—A genus of Diatomaceæ.

Char. Frustules tabular, obsoletely stalked, subsequently connected by isthmi, and with transverse, short, interrupted, capitate vittæ; valves in side view with lateral inflations.

T. musica (Pl. 19. fig. 33, side view; Pl. 25. fig. 10, front view). Frustules very faintly punctate, in front view rectangular oblong; side view equally inflated in the middle and at the ends, in older specimens constricted in the middle, inflated beyond the middle towards both ends, the apices produced and obtuse, the nodules separated by septa. Length 1-180″.

T. indica (*Anaulus ind.*, E.).

BIBL. Ehr. *Abh. Berl. Ak.* 1841, 402; Kütz. *Bacill.* 128; *Sp. Alg.* 119; Pritchard, *Inf.* 850.

TESSEL'LA, Ehr.—A genus of Diatomaceæ.

Char. Frustules broadly tabular, not concatenate, with crowded, longitudinal, alternate vittæ, interrupted in the middle; stipes absent (?). Marine.

T. interrupta (Pl. 19. fig. 35). Length of frustules 1-580; breadth 1-560 to 1-120″. Found with *Striatella.*

BIBL. Ehr. *Inf.* 202; Kütz. *Bacill.* 125; *Sp. Alg.* 114; Pritchard, *Inf.* 804.

TESTAMŒBIFOR'MIA, Carter.—Parasitic, lobular, and wild-growing Foraminifera, some nearly ½ inch long. *Holocladnia* and *Cysteodictynia* with calcareous, *Ceratestina* with chitinous test. Gulf of Manaar. (H. C. Carter, *Ann. N. H.* June 1880, 446.)

TEST-OBJECTS. — Test-objects are microscopic objects used to determine the value of object-glasses.

We must presume that the reader has perused the remarks upon object-glasses in the INTRODUCTION (p. xvi), also the article ANGULAR APERTURE; otherwise the

observations made here will be unintelligible.

The main points in which object-glasses differ from each other are four: viz. their magnifying power; their defining power; their penetrating power; and their corrective adaptations.

The magnifying or separating power scarcely requires notice; it must be adapted to the size of the objects likely to come under examination. Usually, several object-glasses are kept, of different powers; at all events, if scientific investigations are to be pursued, a power of 400 diameters must be accessible, and this without the use of the highest eyepiece. The magnifying power should be ascertained by MEASUREMENT, and not by judging from the focal length.

Good defining power is the most important character of an object-glass; and if good in respect to this, the dark boundary lines of the test-objects will appear clear, black, sharp, as if engraved, and quite free from colour. If this is ascertained to be the case, the higher eyepieces should be put on; and it must be observed that although the sharpness of the outline is somewhat diminished, all the parts are clearly distinguishable as before. In this examination the light should be as direct as possible.

The power of displaying the minute or internal structural peculiarities of objects, or the penetrating power, as it is called, depends upon two distinct circumstances—the goodness of the defining power, and the magnitude of the angular aperture of the object-glass: the degree of obliquity of the light is also of great importance in connexion with the latter.

Thus, in examining the scale of a *Podura* (Pl. 1. fig. 12 *a*, *b*, *c*), the magnifying power being sufficiently high, if the defining power be good, the wedge-shaped bodies will be clearly and sharply displayed by direct light, and whether the angular aperture be large or small. But if we examine a valve of *Pleurosigma* (Pl. 1. figs. 17 & 18) by direct light, the minute structure will be invisible, however small or large the angular aperture may be, or however perfect the defining power; but if the light be thrown obliquely, and the aperture be sufficient, the striæ will at once become evident. Thus there are two distinct kinds of penetrating power, one of which is the same as the defining power, the other depending upon a different cause; hence the term penetration or penetrating power should be laid aside, as tending to cause confusion, the properties of object-glasses being reducible simply to their defining power and their angular aperture.

In recent times, a new meaning has been assigned to the term penetrating power, viz. that of rendering a certain thickness of an object visible at one time. This depends upon the smallness of the angle of aperture of the object-glass. It seems a useless innovation.

The defining power should be tested upon the different objects mentioned below in connexion with each object-glass, and the angular aperture should be determined by measurement (ANGULAR APERTURE); for judgment founded upon the examination of the valves of the Diatomaceæ may be very fallacious to an unpractised observer, on account of the influence of the obliquity of the light, and of the correcting adjustment. If, however, an opinion is to be formed in this way, the valves should be examined by oblique light thrown from all sides, as with the central stop in the condenser, so that the dots may be viewed; for an object-glass may show the lines very fairly, but the dots very badly.

The correcting adjustment is of importance in examining very delicate objects or structures with the high powers; it should therefore always be present.

We subjoin a list of a few of the objects which will be found most suitable for the purpose of testing an object-glass.

1½ or 2-inch object-glass. Magnifying power 20 diameters.

Test-objects: the pygidium of the flea (Pl. 1. fig. 13 *a*), in which the general outline and the hairs should be distinct; the hair of the mouse (Pl. 1. fig. 3). Also, as an opaque object, a piece of an injected preparation (Pl. 39. figs. 33–35).

1-inch or ½rds object-glass. Magnifying power 60 diameters.

Tests: hair of *Dermestes* (Pl. 1. fig 1); of the bat (fig. 2); of the mouse (fig. 3); the pygidium of the flea, the outline of the areolæ being distinguishable under the high eyepiece (120 to 200 diameters), but not the rays. Also an injection, as a piece of lung.

¼-inch or $\frac{1}{25}$ths-inch object-glass. Magnifying power 100 to 120 diameters.

Tests: hairs (Pl. 1. figs. 1, 2, 3); the disks of deal (fig. 4); the coarser scales of *Lepisma* (fig. 6 *a*); the pygidium of the flea

(fig. 13 *a*, *b*), the entire structure visible under the high eyepiece; a dark scale of *Podura* (Pl. 1. fig. 12 *b*).

$\frac{1}{4}$-inch object-glass. Magnifying power 220 diameters.

Tests: hair of *Dermestes*; the disks of deal; the salivary corpuscles (Pl. 1. fig. 5), the moving molecules being clearly distinguishable; the smaller scales of *Lepisma* (Pl. 1. fig. 6 *b*, *c*); the scales of *Podura*; the filaments of *Didymohelix* (fig. 10 *a*); the pygidium of the flea, and the scales of *Pontia brassicæ* (Pl. 34. fig. 24).

$\frac{1}{8}$th-inch object-glass. Magnifying power 420 to 450 diameters

Tests: the paler scales of *Podura*; the pygidium of the flea; the scales of *Pontia brassicæ*; the filaments of *Didymohelix*, showing the component fibres; the salivary corpuscles.

$\frac{1}{12}$th or $\frac{1}{16}$th-inch object-glass. Magnifying power 600 to 650 diameters.

Tests: the paler scales of *Podura*; the filaments of *Didymohelix* mounted in balsam; and the primitive fibrillæ of muscular fibre (Pl. 22. fig. 36 *b*, *d*).

$\frac{1}{25}$th and upwards. Magnifying power 1250 to 2000 diameters.

Tests: the more delicate of the above objects, and the finest Nobert's lines.

It will be observed that we have omitted the tests for angular aperture, which are often now regarded as the true tests of the value of an object-glass. Those, however, who wish for an interesting series of difficult objects in this respect, may use that of Dippel, viz.: the valves of *Pleurosigma formosum, attenuatum, angulatum*; *Grammatophora marina*; *Nitzschia sigmoidea*; *Navicula rhomboides*; *N. affinis*, Amici's test-object, that used at the Exhibition of 1862, mounted in balsam, the transverse lines; *Surirella gemma*, the longitudinal lines; *Grammatophora subtilissima*; *Frustulia saxonica*, and Bailey's *Hyalodiscus subtilissimus*. *Nitzschia tænia* and *Berkeleya fragilis* are also fine objects. Möller's or Rodig's Test-plates may also be used. These consist of a series of the valves of Diatomaceæ, arranged according to their difficulty, and mounted on a glass plate in balsam.

We shall now offer a few

General remarks on the application of test-objects to the choice of an object-glass. A great difficulty presents itself in this question in the case of persons commencing the use of the microscope; for on viewing almost any object, they will see so much that was invisible before, that they are naturally led to regard an object-glass as good which may simply possess tolerably magnifying power.

There is also some difficulty to an unpractised eye in discriminating between a well-defined margin of an object, and one which is ill-defined. This may be overcome by purchasing one or two test-objects from those who mount objects for sale, and first viewing them under their microscopes; or by examining some of the objects exhibited at the evening meetings of the learned societies.

The objects themselves are also variable, some being much more delicate than others even of the same kind. Moreover objects viewed under immersion-glasses are more brilliant than under the dry object-glasses.

The manner in which objects are mounted is also of importance; for if they be immersed in too much balsam or covered by too thick a cover, no object-glass will show them well, however good it may be. Hence the necessity of purchasing the test-objects, in the case of an inexperienced observer. Any of these may be obtained from Norman, Fountain Place, City Road; Wheeler, 48 Tollington Road, Holloway; Baker, 244 High Holborn; of Smith and Beck, Ross, or Powell; or Bourgoyne, of Paris.

A few notes upon the test-objects themselves may not be out of place here.

Hairs of animals (Pl. 1. figs. 1–3). These should be mounted in Canada balsam. Many of those represented in Pl. 29 might be used with equal advantage.

Disks of deal (Pl. 1. fig. 4), form a good test-object on account of their freedom from colour, whence the colours from uncorrected chromatic aberration are easily seen with a bad object-glass.

Salivary globules (Pl. 1. fig. 5 *a*, *b*, *c*). Obtained from the saliva. A good test-object for those engaged in physiological investigations; the marginal granules and the moving molecules should be very distinct.

Scales of insects (Pl. 1. figs. 6 *a*, *b*, *c*, 12 *a*, *b*, *c*; Pl. 34. fig. 24). These should be mounted dry. The scales of *Tinea* and many others have nothing to recommend them. Nor do we advise the use of those scales which exhibit the transverse striæ by oblique light, as those of *Morpho* (Pl. 1. fig. 7), of *Hipparchia* (fig. 9), &c., as they are easy tests even to inferior English object-glasses of the present day. The long scales of *Pontia brassicæ*, however, are good.

Didymohelix (Pl. 1. fig. 10 *a*, *b*, *c*, *d*). The filaments should be mounted in solution of chloride of calcium, or in Canada balsam. It is very difficult to display the component fibres of this beautiful object when in balsam. It also forms a good test of magnifying power.

Didymoprium (Pl. 1. fig. 11). The longitudinal lines upon the cells require considerable magnifying power.

The pygidium of PULEX. An excellent test-object, mounted in as small a quantity of balsam as possible. Dujardin represents the rays upon the disks as round, like so many beads, whereas they are wedge-shaped with the bases outwards.

The valves of the Diatomaceæ. It is a difficult matter to show the lines upon *Grammatophora marina* with an object-glass of 110° of angular aperture, requiring extremely oblique light; but many of those mentioned above are far more difficult.

The ultimate fibrillæ of muscular fibre (Pl. 22. fig. 36). Mounted in liquid. Kölliker represented them as beaded (fig. 36 *c*); they have also been represented as in *a*: probably both these inaccuracies arise from imperfect adjustment, and from their immersion in too much liquid. Their true structure is figured in *b*, *d*, *e*.

Nobert's test-lines. See NOBERT'S LINES.

We have omitted to notice several test-objects, as the scales of some insects, a minute globule of mercury, &c., because the former have been so obscurely described that we are unable to comprehend in what the test-structure consists; and the test-appearances presented by the latter viewed as an opaque object are inappreciable to one unaccustomed to the use of the microscope, by whom mainly are remarks upon test-objects required. See on this matter, Wenham, in Beale's How &c. p. 436.

Chevalier's test-object consists of the scales of *Pontia brassicæ* (Pl. 34. fig. 24), the granules being rendered distinct; this is a test for definition.

Mohl recommended the scales of *Hipparchia janira* for testing penetrating power; pollen-grains, the scaly elytra of the diamond-beetle, or bat's hair, for definition.

Schacht's test-object consists of the scales of *Hipparchia janira* (Pl. 1. fig. 9 *c*), a test for moderate angular aperture and oblique light.

BIBL. That of the INTRODUCTION, and of ANGULAR APERTURE.

TE'THEA, Lam.—A genus of marine Sponges.

Char. Solid and compact, rounded, covered with a skin; without sensible pores; interior fleshy, with acicular and globulo-subulate spines (Pl. 45. fig. *e*).

BIBL. Johnston, *Br. Spong.* 81; Gosse, *Mar. Zool.* i.; Huxley, *Ann. N. H.* 1851, vii. 370.

TETMEM'ORUS, Ralfs.—A genus of Desmidiaceæ.

Char. Cells single, simple, elongated, straight, cylindrical or fusiform, constricted in the middle; segments emarginate at the ends.

Sporangia square or round.

T. granulatus (Pl. 14. figs. 33, 34). Cells fusiform both in front and side view, ends colourless and lip-like; dots irregular. Length 1-130″.

T. lævis (Pl. 14. fig. 35, in conjugation). Cells in front view somewhat tapering, ends truncate; side view fusiform; dots none, or very indistinct (under ord. illum.). Length 1-350′.

T. Brebissonii. Dots in longitudinal rows.

BIBL. Ralfs, *Br. Desmid.* 145; Rabenht. *Alg.* iii. 139.

TETRACHAS'TRUM = *Micrasterias* pt.

TETRACTIN'IUM, Brn. = *Pediastrum* pt.

TETRACY'CLUS, Ralfs.—A genus of Diatomaceæ.

Char. Frustules compound, aggregated into a filament, in front view broadly tabular with longitudinal interrupted vittæ; valves inflated on each side in the middle.

Valves with coarse transverse striæ.

T. Thienemanni, Ehr. (*lacustris*, Ralfs) (Pl. 17. fig. 28). Valves rounded or subacute at ends, inflations rounded.

T. emarginatus. As the last, but valves constricted towards the rounded and subapiculate ends, and the inflations emarginate.

BIBL. Ralfs, *Ann. N. H.* 1843, xii. 105; Kützing, *Sp. Alg.* 118; Smith, *Br. Diat.* ii. 37; Rabenht. *Alg.* i. 302.

TETRAGON'ICEPS, Brady.—A genus of Copepodous Entomostraca. *T. malleolata*, in dredgings. (Brady, *Copep.* ii. 65.)

TETRAMI'TUS, Perty.—A genus of Flagellate Infusoria. Free, changeable, tapering behind, truncate in front; flagella four. Three species; in stale water and infusions. (Perty, *Lebensf.* 170; Kent, *Inf.* 313.)

TETRAN'YCHUS, Duf.—A genus of Trombidina (Acarina). Spinning-mites.

Char. Palpi incumbent upon the rostrum, stout, short, and conical; mandibles and labium as in *Rhaphignathus*; palpi chelate; coxæ inserted in two groups on each side, one for the two anterior, the other for the two posterior; anterior legs longest, third joint (femur) largest; claws short and greatly curved, and with rigid bulb-pointed hairs.

Several species and varieties, red and green.

T. telarius, the red spider. Yellowish; abdomen produced behind; a dark yellow spot on each side of the back. On ill-conditioned greenhouse-plants, forming a web.

T. glaber (Pl. 6. fig. 32). Very minute; eyes two, whitish, upon the anterior prominence. Under stones in damp places.

T. lapidum (*cristatus*, Dugès) (Pl. 6. fig. 35). Legs slender, anterior very long; eyes three on each side; several rows of white points upon the back and margins of the body. Under stones and upon plants.

Claparède places *Trombidium autumnale* in this genus.

Bibl. Dugès, *Ann. Sc. N.* 2. i. 24, & ii. 55; Gervais, *Walckenaer's Aptères*, ii. 165; Dufour, *Ann. Sc. N.* i. xxv. 279; Koch, *Deutschl. Crustac.*; Boisduval, *Ent. Hort.* 88; Murray, *Ec. Ent.* 97.

TETRAPE'DIA, Reinsch.—A genus of Unicellular Algæ.

Char. Cells compressed, quadrangular or triangular, equilateral, becoming subdivided into quadrate or connate segments or rounded lobes, either by deep vertical or oblique markings, or by wide angular or rounded sinuses. (Archer, *Qu. Mic. Jn.* 1872, 351.)

TETRAP'LOA, Berk. and Br.—A genus of Torulacei (Coniomycetous Fungi), comprising at present a single species, *T. aristata*, a curious little fungus growing upon leaves of grass. See Torulaceæ.

TETRAP'LODON, Br. and Sch.—A genus of Splachnaceæ (Acrocarpous operculate Mosses). *T. mnioides* and *angustatus*, on dung in mountainous regions.

TETRASEL'MIS, Stein.—A genus of Flagellate Infusoria. Free, obovate or oblong; flagella four; protoplasm green, with an eye-spot. *T. cordiformis*, fresh-water. (Kent, *Inf.* 315.)

TETRAS'PORA, Link.—A genus of Palmellaceæ (Confervoid Algæ), nearly related to the Ulvaceæ; indeed it is very difficult to draw any very distinct line of demarcation between *Tetraspora* and *Monostroma*, the fronds of both of which are membranous strata formed of a single layer of cells; the latter, however, has its constituent cells crowded, while in *Tetraspora* the green cell-contents lie scattered, mostly in groups of two or four, in the gelatinous frond. Thuret states that the cells possess long cilia in the stage when they are imbedded in a continuous frond (Pl. 7. fig. 10). Development by the ciliated cell-contents breaking out as swarming zoospores. Two recorded British species appear to be distinct, growing in stagnant pools.

T. gelatinosa (Pl. 7. fig. 10). Frond gelatinous, soft, of irregular shape and division, pale green; cells 1-10800 to 1-4200″ in diameter (Kützing, *Tab. Phyc.* i. p. 28).

T. lubrica. Frond green, elongated, mesentery-shaped, lobed and sinuated, lobes often anastomosing; cells angulo-globose, 1-3600″ in diameter (Kützing, *l. c.* pl. 30).

Bibl. Hassall, *Alg.* 300, pl. 78; Kützing, *Sp. Alg.* 225; *Tab. Phyc.* i.; Thuret, *Ann. Sc. N.* 3. xiv. 248, pl. 21; Nägeli, *Einzell. Alg.* 71, pl. 2; Rabenht. *Alg.* iii. 38.

TETRASPORES. See Spores.

TETRATAX'IS, Ehr. — A Valvuline Foraminifer, with four chambers in a whorl. Fossil (Carboniferous). (Parker and Jones, *Ann. N. H.* 4. x. 259.)

TEXTILE FABRICS.—The components of these are noticed under the heads of silk, wool, fibrous and filamentous structures.

Bibl. Wiesner, *Techn. Mikr.*; Schlesinger, *Mikr. Untersuch. d. Gespinntfasern*, 1872; Hutton, *M. M. Jn.* vii. 259; Lateaux, *Man. Techn. Micr.*

TEXTULA'RIA, Defrance (Textilaria, Ehr.).—A protean genus of hyaline Foraminifera, having typically a binary series of subglobular or subquadrate chambers arranged alternately on two sides of a longitudinal axis, and usually increasing in size from the oldest (at apex) to the youngest, with a slit-like apperture in the wall of each chamber (*T. cuneiformis*, Pl. 23. fig. 47). The shell is flattened in one direction in *Vulvulina*, with oblique chambers and terminal slit, *V. gramen* (Pl. 23. fig. 49); in another, in *Cuneolina*, with transverse chambers and a row of apertural pores in normal position. Irregularly alternate and biserial chambers, passing into a short linear row, with a necked and rimmed aperture, constitute *Heterostomella*; *Bigenerina* has many uniserial chambers, with a terminal pouting mouth (*B. agglutinans*, Pl. 23. fig. 50).

Instead of the biserial form, frequently the shell begins with a triserial arrangement of chambers (*Verneuilina*, with contracted aperture; *Candeina*?, with perforate septa). The Verneuiline commencement is often succeeded by the usual two alternating rows (*Gaudryina, G. pupoides*, Pl. 23. fig. 48), or by a linear growth with terminal aperture (*Tritaxia*). The triserial varieties are sometimes twisted. If *Vulvulina* takes on the linear growth, we have *Venilina*.

The early chambers of *Textularia* and its modifications are not unfrequently coiled (*Spiroplecta*). *Textularia* (*Sp.*) *annectens* (Pl. 23. fig. 52), from the Gault, commenced spirally, proceeded biserially, and ended with uniserial chambers.

Large *Textulariæ* are rarely porous and translucent; they usually become sandy (*Plecanium*).

Common in all seas, and fossil in all formations from the Silurian upwards.

BIBL. D'Orbigny, *For. Foss. Vien.* 245; Williamson, *For.* 75; Morris, *Cat. Br. Foss.* 43; Bronn, *Index Pal.* art. *Text.*; Ehrenberg, *Mikrog.*; Schultze, *Org. Polyth.* 62; Carpenter, *For.* 189; Parker and Jones, *Ann. N. H.* 3. xi. 91; 4. ix. 298, x. 189, 196, 259; Brady, *Carb. For., Pal. Soc.* 1876, 130.

THALAMOPORA, Reuss. — A large, subcylindric, zoophytoid Foraminifer, composed of superimposed chambers, with labyrinthic and perforated walls, arranged around, and opening into, a central vertical cavity. *Thalamopora* exhibits characters of alliance with *Polytrema, Carpenteria, Tinoporus, Cymbalopora*, and, through the last, with *Planorbulina* and others of the *Rotalina*. It is among the Perforata what *Dactylopora* is among the Imperforata. (Reuss, *Geinitz's Elbthalgebirge*, 1872, 139.)

THALASSICOL'LIDA, Huxley. — A family of Radiolarian Rhizopoda.

Char. Composed of structureless cysts, single or aggregate, containing cellular elements and sarcode, giving off radiate pseudopodia, which sometimes run into each other and form a network. Nucleus present, but no contracting vesicle. Numerous yellow cells occur scattered through them; and occasionally a few may be seen suspended within the external gelatinous structure. The whole organism is permeated by spicula, or sustained by a fenestrated shell. The most common genera are *Sphærozoum, Collosphæra*, and *Thalassicolla*. They are marine, in tropical and subtropical seas.

BIBL. Huxley, *Ann. N. H.* 2. viii. 1851, 489; *Qu. Mic. Jn.* iv. 1856, 72; Müller, *Thalass.*; Haeckel, *Radiolarien*, 1862; Wallich, *Ann. N. H.* 1869, iii. 97.

THALES'TRIS, Claus. — A genus of Copepodous Entomostraca. Ten species, marine. (Brady, *Copep., Ray Soc.* ii. 120.)

THAMNO'LIA, Ach. — A genus of Cladodei (Lichenaceous Lichens).

T. vermicularis; on mossy earth; rare. (Leighton, *Lich. Fl.* 74.)

THAMNOM'YCES, Ehr. — A genus of Sphæriacei (Ascomycetous Fungi). It has distinct asci and sporidia. (Berk. *Br. Flor.* ii. pt. 2. 284; Fries, *Sum. Veg.* 382.)

THAUMAN'TIAS, Eschscholtz. — A genus of Campanulariidæ.

Char. Stem simple (or branched?), rooted by a thread-like stolon; cells campanulate; polypes with a funnel-shaped proboscis; reproduction by free medusiform buds.

T. inconspicua, Forbes. Common off the Hebrides. (Hincks, *Hyd. Zooph.* 178.)

THAUMATONE'MA, Grev. — A genus of Diatomaceæ. (Grev. *Mic. Tr.* 1863, 76.)

THECA. — A term used very loosely in the descriptions of Cryptogamic plants. In the case of the Lichens and Fungi it is synonymous with ASCUS, a sac in which free spores are developed; these are called *theca-spores* or ascospores, in contrast with BASIDIOSPORES or stylospores. In the higher Cryptogamia, as Ferns, &c., it is used in the sense of *sporangium*.

THECAMONADI'NA, Duj. — A family of Infusoria (=Cryptomonadina and some Astasiæa, E.).

Char. Usually coloured; covered with a non-contractile tegument, which is either hard and brittle, or membranous; locomotive organs one or more flagelliform filaments.

Many are Algæ, or their spores. They are minute, usually green, but some are red; and they often colour stagnant water from existing in vast numbers. They are mostly recognizable by their rigidity and the uniformity of their motion.

Dujardin subdivided them thus:—

A single flagelliform filament.	Body ovoid or globular	Tegument hard and brittle		1. *Trachelomonas.*
		Tegument membranous		2. *Cryptomonas.*
	Body depressed or foliaceous	with a tail-like prolongation		3. *Phacus* (*Euglena* pt., E.)
		without a prolongation		4. *Crumenula.*
Two filaments.	Two similar filaments			5. *Diselmis* (*Chlamidomonas*, E.).
	One flagelliform filament, and one trailing retractile filament	Body prismatic or boat-shaped		6. *Plaotia.*
		Body ovoid or pip-shaped		7. *Anisonema.*
Several filaments	Body prolonged into a point in front			8. *Oxyrrhis.*

Bibl. Dujardin, *Infus.* 323.

THELID'IUM, Mass.—A genus of Microlichens parasitic on the thallus of Lecanoræ.

Char. Spores subfusiform, 2-locular, colourless. (Lindsay, *Qu. Mic. Jn.* 1869, 346.)

THELOCAR'PON, Nyl.—A genus of Pyrenodei (Lichenaceous Lichens).

Four species. (Leighton, *Lich. Fl.* 439; Lindsay, *Qu. Mic. Jn.* 1869, 345.)

THELOTRE'MA, Ach.—A genus of Placoidei (Lichenaceous Lichens), containing two British species. (Leighton, *Lich. Fl.* 238.)

THEO'RUS, Ehr.—A genus of Rotatoria, of the family Hydatinæa.

Char. Eyes colourless, more than three, cervical, in two groups; foot forked; jaws each with a single tooth.

T. vernalis (Pl. 44. fig. 32). Toes small, frontal hook absent. Aquatic; length 1-140 to 1-120″.

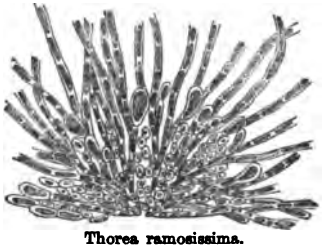
T. uncinatus. Toes long, frontal (or rather cervical) region with hooks; fresh-water; length 1-240″.

Bibl. Ehr. *Inf.* 454; Pritchard, *Inf.* 690.

THLIPSU'RA, J. & H.—A Cytheroid Ostracode in the Silurian strata. (Jones and Holl, *Ann. N. H.* 4. iii. 213.)

THO'REA, Bory.—A genus of Batrachospermeæ (Confervoid Algæ), of which one species (*T. ramosissima*) occurs in Britain; its fronds are olive-black, branched filaments, a foot or more long, about as thick

Fig. 740.



Thorea ramosissima.

Horizontal section of a filament (halved). The semicircular denser portion represents the axis, the loose spreading branches the villi. Magnified 25 diameters.

as a crow-quill, with a villous surface. The filaments are composed of radiating branched cells, closely compacted into a kind of solid axis, from which proceed lax, radiating ramuli, forming the villous surface. The spores or sporangial cells arise from these ramules (fig. 740).

Bibl. Kütz. *Phyc. generalis*, pl. 16, *Sp. Alg.* 534; *Eng. Bot.* Supp. No. 2948; Hassall, *Alg.* 64; Rabenht. *Alg.* iii. 418.

THOREL'LIA, Boeck. — A genus of Copepodous Entomostraca. *T. brunnea*, on *Laminaria*. (Brady, *Copep.* i. 95.)

THUIA'RIA, Flem.—A genus of Polypi, of the Order Hydroida, and family Sertulariidæ.

Char. Those of *Sertularia*; but the cells closely pressed to or imbedded in the stem or branches. Two species:

T. thuia. Cells ovate-elliptical, acutish; vessicles pear-shaped. On shells from deep water.

T. articulata. Cells ovate, obtuse or truncate, vesicles elliptical; rare.

Bibl. Johnston, *Br. Zooph.* 83; Gosse, *Mar. Zool.* ii. 23; Hincks, *Hyd. Zooph.*

THU'JA, L.—A genus of Coniferæ (Gymnospermous Plants), to which belongs the *arbor vitæ* of gardens, *Thuja occidentalis*; *T. orientalis* is placed by some authors under another genus, *Biota*. The characters of Coniferous wood, Gymnospermous ovules, &c., may be observed in these plants (see Coniferæ and Ovule).

THURAM'MINA, Brady.—A subglobular Arenaceous Foraminifer (0·5 mm.), with perforate papillæ; single and enclosing a smaller chamber or group, and adherent. Atlantic and Pacific. (H. B. Brady, *Q. Jn. M. Sc.* n. s. xix. 45.)

THURIC'OLA, Kt.—A genus of Peritrichous Infusoria. Like *Vaginicola*, but sheath with a closeable valve. Three species; salt and fresh water. (Kent, *Inf.* 718.)

THY'AS, Koch.—A genus of Hydrachnea (Acarina). Like *Hydrachna*, but legs formed for walking. *T. venusta.* (Koch, *Uebers.*; Murray, *Ec. Ent.*, fig.)

THYMELEA'CEÆ.—An order of Dicotyledons to which the Spurge-Laurels (*Daphne*) belong. In *D. Lagetto* (=*Lagetta lintearia*) the fibres of the liber are separated into lozenge-shaped meshes, arranged in such beautiful and easily-separable layers, as to have acquired for the plant the name of the Lace-Bark Tree.

See Liber.

THYRSOPOREL'LA, Gümb.—Gümbel divides the *Dactyloporideæ* (see Dactylopora) into (I.) those with chambers:—1. *Haploporella*; segmental, annular, or cylindrical (piled rings), with large chambers and simple traversing canals (6 species, recent and Tertiary): 2. *Dactyloporella*; cylindrical, with large and subsidiary chambers, and branched traversing canals (4 species, Tertiary). (II.) Those without chambers:—3. *Thyrsoporella*; cylindrical,

with simple, swollen, traversing canals, and fascicules of smaller tubes (2 species, Tertiary): 4. *Gyroporella*; cylindrical, with circular canals (14 species, Triassic and Neocomian): 5. *Uteria*; annular, hollow, perforate (1 species, Tertiary).

Bibl. Gümbel, *Abhandl. k. bayer. Akad. Wiss.* II. *Cl.* xi. 1872, p. 231.

THYRSOPTERIS, Kunze.—A genus of Cyatheæ (Polypodiaceous Ferns), with globose, marginal sori, collected into a panicle

Fig. 741.

Fig. 742.

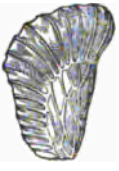
Thyrsopteris elegans.

Fig. 741. A fertile pinna.
Fig. 742. A pinnule converted into a cup-like sorus. Magnified 20 diameters.

distinct from the sterile pinnæ. Capsules sessile, on a globose receptacle; indusium inferior, cup-shaped, the mouth entire. *T. elegans*, tropical. (Hooker, *Syn.* 15.)

Fig. 743.

Fig. 744.



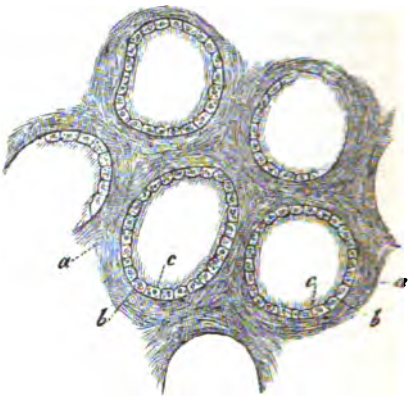
Thyrsopteris elegans.

Fig. 743. Vertical section of the same, with the sporanges removed from the columella.
Fig. 744. Side view of a sporange. Magn. 100 diams.

THY'ROID GLAND.—The thyroid gland is one of the vascular glands, or glands without ducts.

It consists of rounded, closed, glandular vesicles (fig. 745) surrounded by or imbedded in a fibrous stroma (*a*), and aggregated into roundish, elongate, or somewhat polygonal acini or minute lobules, these being grouped in secondary lobules, which unite to form

Fig. 745.

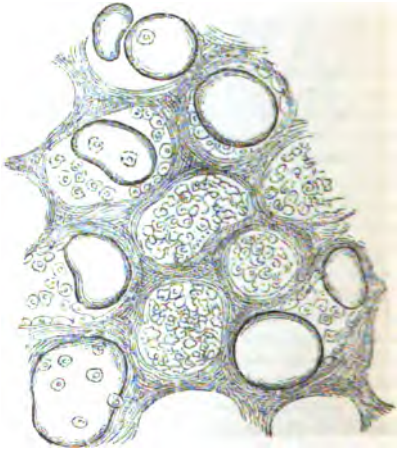


Glandular vesicles from the thyroid gland of a child. *a*, intervening connective tissue; *b*, basement membrane; *c*, epithelium.
Magnified 250 diameters.

lobes. The vesicles are from 1-600 to 1-240″ in diameter, the acini from 1-50 to 1-24″. The stroma is condensed around the lobules, to form a fibrous coat.

The stroma consists of ordinary interlacing bundles of connective tissue, with fine elastic fibres, at its outer surface containing fat-cells.

Fig. 746.



Glandular vesicles with colloid matter
Magnified 50 diameters.

The vesicles consist of a basement mem-

brane (fig. 745 *b*), lined by a single layer of polygonal epithelial cells (*c*), and containing a yellowish, tenacious, albuminous liquid.

The capillaries form plexuses surrounding the vesicles.

In *goître*, the vesicles become greatly enlarged, and confluent, so as to form cysts containing colloid matter, with fat-globules and crystals of cholesterine. The same conditions, in a minor degree, are so frequently met with, that they can scarcely be regarded as abnormal. The epithelium is also often found loose in the vesicles (fig. 746). The minute arteries and capillaries are often found varicose.

BIBL. Kölliker, *Mik. An.* ii. 327; Förster, *Pathol. An.* ii. 233; Verson, *Stricker's Hist.* i. 267.

THYSANU'RA.—An Order of Insects (Spring-tails), to which *Lepisma*, *Petrobius*, *Podura*, and *Lepidocyrtus* belong. See INSECTS.

BIBL. Lubbock, *Thysanura, &c.*, *Ray Soc.* 1873; Murray, *Ec. Ent.* 401.

TICHOTHE'CIUM, Fv.—A genus of Microlichens parasitic on the thallus of many crustaceous and subfoliaceous lichens.

BIBL. Lindsay, *Qu. Mic. Jn.* 1869, 347.

TILLE'TIA, Tulasne.—A genus of Ustilaginei (Hypodermous Fungi), forming the *Bunt*, a kind of blight of various corn-grains, in which the ears are attacked, and the internal substance of the grains is replaced by a fœtid, black powder, consisting of the spores of the fungus. *T. Caries* (*Uredo Caries*, D.C.) attacks wheat and other grain. The interior of the ovaries of the corn is at first occupied by an interwoven mycelium, from which the globular spores arise on short stalks; as the latter grow, the ears become more or less deformed, the mycelium disappears, and the spores are set free as a pulverulent mass. The spores have a reticulated surface; and their pedicel is often found attached (Pl. 27. fig. 13). A distinct species is found in wheat in the United States. (See USTILAGINEI.)

BIBL. Berk. *Br. Fl.* ii. pt. 2. 375; Tulasne, *Ann. Sc. N.* 3. vii. 112, pl. 5; 4. ii. 161.

TILLI'NA, Gruber.—A genus of Holotrichous Infusoria. Free, reniform, pharynx curved; longer cilia round the mouth and the pharynx. *T. magna*; freshwater. (Gruber, *Zeitsch. wiss. Zool.* 1879, *Jn. Mic. Soc.* 1880; Kent, *Inf.* 514.)

TIM'MIA, Hedw.—A genus of Mniaceous Mosses, approaching *Polytrichum* in habit, and *Mnium* in the form of the capsule. One British species, *Timmia austriaca*, on rocks in Scotland.

TIN'EA, Fabr.—A genus of Lepidopterous Insects, of the family Tineidæ.

The small scales from the underside of the wings of *T. vestianella*, the common clothes' moth, have been proposed as test-objects; but they can hardly be regarded as such for object-glasses of the present day. The longitudinal lines form the test-structure.

BIBL. Westwood, *Introd.*; Stainton, *Manual of Butterflies.*

TINOP'ORUS, Carpenter (De Montfort).—A many-shaped Foraminiferal genus of the Globigerinida; globular, subhemispherical, lenticular, or stellate; areolated, granulate, and often spined (baculate). Commencing as a spiral Rotaline (like *Calcarina*), it soon heaps on each face subcyclical layers of quadrangular chambers, with cribrate floors and strong, perforated, radiating septa. The spines consist of "supplemental skeleton," arising from some of the early septa, with an extension of the "canal-system." *Gypsina*, Carter, is an allied but less elaborate form.

Recent, often in great abundance, as *Tinoporus baculatus* of the Australian seas and the Philippines.

BIBL. Parker and Jones, *Ann. N. H.* 3. vi. 34; Carpenter, *For.* 223; Carter, *Ann. N. H.* 4. iv. 215; 5. v. 444.

TINTINNOD'EA.—A family of Heterotrichous Infusoria.

Kent includes in this family, *Tintinnus*, *Tintinnidium*, *Vasicola*, and *Strombidinopsis*.

TINTINNID'IUM, Kt.—A genus of Heterotrichous Infusoria. Like *Tintinnus*, but contained in a mucilaginous cylindrical sheath, adherent to foreign bodies. Three species; marine and freshwater. (Kent, *Inf.* 611.)

TINTINNOP'SIS, Stein.—A genus of Heterotrichous Infusoria. Like *Tintinnus*, but with two independent rings of anterior cilia. *T. beroidea*, marine. (Kent, *Inf.* 617.)

TINTIN'NUS, Schrank.—A genus of Heterotrichous Infusoria, family Tintinnodea.

Char. Single; body contained in a cylindrical, sessile, bell-shaped carapace, to the bottom of which it is attached by a stalk.

Many species.

T. inquilinus (Pl. 32. fig. 4). Body hyaline or yellowish; carapace cylindrical, hyaline. Marine; length 1-240".

Bibl. Ehr. *Inf.* 294; id. *Ber. Berl. Ak.* 1840; Duj. *Inf.* 561; *Ann. N. H.* 1879, iv. 290; Clap. et Lach. *Inf.* 195; Kent, *Inf.* 603.

TISSUE, Fibro-plastic.—A term applied by Lebert to imperfectly developed abnormal connective tissue. The separate elements are often found diffused through normal tissues, or products of inflammatory exudation. They consist of rounded or oblong cells, from 1-2300 to 1-1600″ in diameter, in a more advanced stage becoming fusiform or angular, and finally forming distinct fibres; hence resembling the elements of embryonic connective tissue (Pl. 49. fig. 42). In some instances the development is arrested at one of the early phases, so that the tissue consists almost exclusively of the rounded or the fusiform cells; and in others, the cells enlarge and produce a number of nuclei or secondary cells (Pl. 38. fig. 10 *c*).

Fibro-plastic tissue or its elements are met with in inflammatory effusions upon the serous and synovial membranes (but rarely), in the interstitial effusions of pneumonia, especially when chronic, in cirrhosis of the liver, in the products of suppurating surfaces, on the surface of chronic ulcers and non-malignant fungoid vegetations, in the soft yellow vascular tissue occupying the cancelli of ulcerated bones, in certain tumours, &c.

Bibl. Lebert, *Phys. Path.*; Wedl, *Path. Hist.*; Förster, *Path. Anat.* i.; Rindfleisch, *Path. Gewebel.*

TISSUES, Animal.—The following synoptical arrangement of the principal animal tissues, according to their structure, is intended to facilitate reference to the various articles scattered through the work.

A Simple.

1. *Blastemic* or *protoplastic*. Sarcode.
2. *Membranous*.....Basement membrane.
3. *Cellular*.....
   - Fatty tissue; epithelium; nerve-cells; simple cartilage; unstriated muscular fibre.
4. *Blastemic* and *cellular*
   - Without secondary deposit; true cartilage.
   - With secondary deposit; bone.
5. *Fibrous*.....
   - Connectivetissue; tendon; ligament; elastic tissue; muscle.
6. *Fibrous* and *cellular*.....Fibro-cartilage.
7. *Tubular*.....
   - Without secondary deposit. Vessels.
   - With secondary deposit. Nerve-tubes.

B. Compound. Glands; mucous and serous membranes; skin synovial membrane; teeth.

Bibl. Leydig, *Hist.* 1856; Morel, *Hist.* 1864; Kölliker, *Ic. Hist.* 1865; Brücke, *Elem. Organism.*; Beale, *Simple tissues*; Exner, *Leitf. thier. Gewebe*, 1873; Ranvier, *Hist. technique*; Thin, *Hist.* 1877; Schäfer, *Pract. Hist.* 1877; Gibbes, *Hist.* 1880; Klein and Smith, *Atlas Hist.*; Ork, *Hist.* 1881; Thierfelder, *Atlas path. Hist.* 1881; Satterthwaite, *Hist.* 1881; Stirling, *Hist.* 1881.

TISSUES, Vegetable.—The tissues of which vegetables consist are all composed of cellulose sacs or *cells*, most of them retaining their primary form, constituting cellular tissue, which makes up the greater mass of plants; while others undergo comparatively slight, yet characteristic modifications in form, consistence, and in their mode of union to form other tissues. The tissues may be divided into groups on different principles; but for our purpose a simple arrangement will suffice, based chiefly on the character of the compound tissues, leaving the secondary divisions to be determined by the nature of the component cells.

Cambium tissue, occurring in the growing regions of all plants having stems, is composed of minute cells of variable form, densely filled with protoplasm, and without intercellular passages. It is a transitional structure, forming the first stage of all the rest.

Parenchyma, or cellular tissue, is composed of cells in which the diameter is not excessive in any one direction, and the walls are comparatively thin. This is divided by authors into many sections, according to the form of the cells, the laxity of their coherence, &c. The only distinctions worth note are between:—

a. Parenchyma proper, where the cells have polygonal forms.

b. Merenchyma, where the cells are round, oval: &c.

c. Collenchyma, a form of cellular tissue where the walls are greatly thickened with softish secondary deposits; it occurs beneath the epidermis of many herbaceous plants, in the fronds of the larger Algæ, of Lichens, &c.

d. Sclerenchyma. Where the secondary deposit or thickening is hard, as in the bony cellular tissue of the shells, stones of fruits, &c.

Prosenchyma. Cellular tissue, usually forming the mass of wood and various fibrous structures, where the cells are attenuated to a point at each end, the cells, or fibres, being intercalated and applied side to side.

Tela contexta. This name is used to

indicate the interwoven tissue formed by the ramified jointed filaments of the mycelium of Fungi, and the cottony substance in the interior of the thallus of many Lichens.

Fibro-vascular tissue is composed of vessels, ducts, and prosenchymatous cells or "fibres" associated in various ways, forming fibrous or fibro-vascular bundles, which either remain distinct or cohere to form masses of wood.

a. Fibrous bundles, occurring in liber, in the outer part of many Monocotyledonous stems, and in the stems of Mosses, consist of cords formed of prosenchymatous cells, which are often of great length.

b. Fibro-vascular bundles, composed of vessels and ducts together with prosenchyma, form the woody fibres of every part (except the bark) of all plants above the Mosses.

c. Sieve-tubes or Clathrate tissue, found in the bark of Dicotyledons and in the vascular bundles of Monocotyledons.

Laticiferous tissue and *Reservoirs for Secretion*, composed either of intercellular passages lined by a proper coat, or of lines of cells fused at their ends, so as to form continuous branched canals; they occur in the bark, wood, and pith of the Flowering Plants.

Epidermal tissue. Composed of cellular tissue, forming a continuous firm layer over the external surface of the higher plants. It is composed usually of a single layer of cells, and presents very varied appendages, such as HAIRS, GLANDS, &c., and is perforated by STOMATA. Its outer surface is rendered dense by the deposit of CUTICLE. The epidermis is replaced, on stems, by the CORK or suberous layer of BARK.

BIBL. Henfrey-Masters, *Bot.*; Sachs, *Bot.*; V. Tieghem, *Bot.* 1881; and the Bibl. of the above heads.

Fig. 747.

Tmesipteris tannensis.

TMESIP'TERIS.—A genus of Psiloteæ (Lycopodiaceæ), remarkable for its peculiar habit and bivalved sporanges bursting by a vertical crack. See LYCOPODIACEÆ.

TOBACCO.—The leaves of Tobacco (*Nicotiana Tabacum* and other species) may be distinguished from the leaves of the plants commonly used for adulteration by the peculiar structure of the EPIDERMIS with its hairs (Pl. 2. fig. 16), and the form of the section of its Fibro-vascular bundles. Paper, which has been sometimes used, is still more readily detected. The epidermis of the dock-leaf (Pl. 2. fig. 17), that of rhubarb (fig. 18), and of colt's-foot (fig. 19), are also characteristic. As in other similar cases, the nature of a foreign ingredient can only be determined by careful comparative investigations.

BIBL. Hassall, *Food &c.*; Prescott, *Tobacco and its Adulterations*, 1858.

TO'DEA, Willdenow.—A genus of Osmundaceous Ferns (figs. 748–50). Four species. Exotic.

Fig. 748. Fig. 749. Fig. 750.

Todea africana.
Sporanges closed and bursting.
Magnified 40 diameters.

TOLYPOTH'RIX, Kütz.—A genus of Oscillatoriaceæ (Confervoid Algæ), apparently not very satisfactorily defined. Hassall describes six species as British, of which *T. distorta* (Pl. 8. fig. 14) is said to be common, adhering to sticks, stems, &c. in stagnant water, forming tufts from 1-2 to 1″ in height, dark green when fresh, verdigris- or blue-green when dry; primary filaments 1-1800 to 1-1440″ in diameter; joints about as long as broad. *Tolypothrix Dillwynii* = *Desmonema*, Eng. Bot. Supp. no. 2958.

BIBL. Kütz. *Sp. Alg.* 312; *Tab. Phyc.* ii. pls. 31–33; Hassall, *Alg.* 240, pls. 68 & 69; Rabenh. *Alg.* ii. 273.

TONGUE.—We have only space here to notice the beautiful papillæ of the tongue.

The filiform or conical papillæ (fig. 755) are whitish, very numerous, and occupy the intervals between the fungiform papillæ.

The papillæ of the mucous membrane at their bases (*p*, *p*) are conical, and covered either at the end only, or all over the surface with a number of smaller or secondary papillæ; the whole being coated by an epithelial investment (*e*), terminating in a tuft of free filiform processes (*f*). The inner layers of the epithelium agree in structure with that of the mouth, whilst the outer layers, and especially the epithelium of the processes, resemble rather the scales of the epidermis, in their hardness, small size, and

Fig. 751.

Fig. 753.

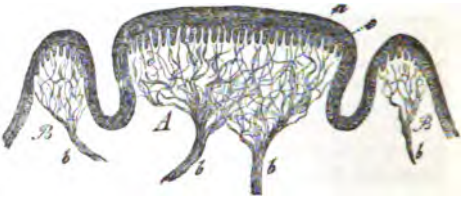


Fig. 752.

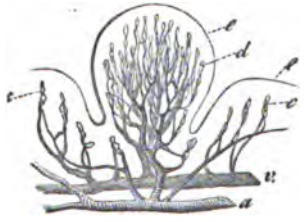


Fig. 754.

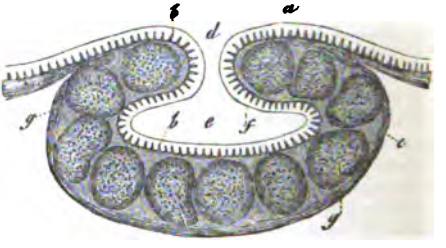


Fig. 751. Fungiform papilla, covered by the epithelium *e* on one side, and with the secondary or simple papillæ *p*. Magnified 35 diameters.

Fig. 752. The same, with the vessels; the epithelium *e* represented in outline. *a*, artery; *v*, vein; *d*, capillary loops of the simple papilla; *c*, capillaries in the simple papillæ of the mucous membrane at the base of the fungiform papilla. Magnified 18 diameters.

Fig. 753. Perpendicular section of a human circumvallate papilla. *A*, proper papilla; *B*, wall; *a*, epithelium; *b b*, nerves of the papilla and wall; *c*, secondary papillæ. Magnified 10 diameters.

Fig. 754. Follicular gland from the root of the human tongue. *a*, epithelium; *b*, papillæ of the mucous membrane; *c*, areolar coat; *e*, cavity; *f*, epithelium lining it; *g g*, follicles in the thick capsule. Magnified 30 diameters.

considerable resistance to the action of alkalies and acids. The papillæ themselves consist of areolar tissue, with a large number of undulating nuclear fibres, each containing a small artery (*a*) and vein (*v*), with intermediate plexus of looped capillaries, and numerous nerve-tubes.

The fungiform or clavate papillæ (fig. 751) are reddish, distributed over the entire surface of the tongue, and are very numerous at its point. Each has at its base a club-shaped mucous papilla, and is covered all over with simple or secondary conical papillæ (*p*, *p*) and a simple epithelial layer (*e*), without filiform processes. The vessels (fig. 752) are more numerous, but otherwise resemble those in the filiform papillæ.

The circumvallate or lenticular papillæ (fig. 753) consist of a flattened central papilla (*A*), surrounded by an elevated wall or ridge (*B*). The flat surface is furnished with crowded conical secondary papillæ (*c*), the whole being covered with epithelium (*a*) free from processes. The wall appears as a simple fold of the mucous membrane, and also exhibits beneath its smooth epithelial coat numerous rows of simple, conical, secondary papillæ. In other respects these

papillæ do not differ essentially in structure from the fungiform.

In some of the papillæ of the tongue, axial bodies are found resembling those in the papillæ of the skin.

The epithelial processes of the filiform papillæ are often covered by a fungus (*Leptothrix*), the mycelium closely surrounding them, whilst some of the filaments project from the surface.

Fig. 755.

Two human filiform papillæ, one with epithelium. *p, p*, papillæ; *a, v*, artery and vein, with the capillary loops; *e*, epithelial covering; *f*, its processes.

Magnified 35 diameters.

The glands of the tongue consist of mucous and follicular glands.

The mucous glands resemble those of the mouth (MOUTH).

The follicular glands are most numerous between the epiglottis and the circumvallate papillæ, and are so superficially situated as to form projections of the mucous membrane. They form lenticular or globular masses, from 1-24 to 1-6″ in diameter, imbedded in the submucous tissue; and in the middle of the free surface is the orifice (754 *d*) of a conical cavity (*e*), formed by a depression of the mucous membrane. Each gland forms a thick-walled capsule, surrounded by a fibrous coat (*c*) continuous with the deeper portion of the mucous membrane, and lined internally by a prolongation of the mucous membrane with papillæ and epithelium (*b, a*); and between the two are closed capsules or follicles (*g*), imbedded in a fibrous and vascular basis. The follicles are from 1-120 to 1-48″ in diameter, rounded or somewhat elongate, whitish, composed of a coat of connective tissue without elastic fibres, and with greyish-white contents consisting of cells 1-6000 to 1-4000″ in diameter and free nuclei.

In the small portion of tissue constituting one of the papillæ of the frog's tongue, Beale found striped muscular fibres, capillary vessels, purely sensitive nervous fibres forming an expanded terminal plexus at the summit of the papilla, motor nerve-fibres distributed to the muscle, nerve-fibres around the capillary vessels, and a few very fine nerve-fibres ramifying in different parts of the papillæ. All of these are imbedded in and held together by connective tissue, forming the body of the papilla, the summit of which is surmounted by a peculiar epithelium-like tissue, perhaps connected with the nerves and belonging to nerve-texture, while its sides are covered with ordinary ciliated epithelium. The fur of the tongue, which is usually considered to be composed of epithelium, is stated by Butlin to consist of Schizomycetous fungi.

BIBL. Todd and Bowman, *Phys.*; Ward, *Todd's Cycl. An. & Phys.*; Salter, *ibid.*; Huxley, *Mic. Jn.* ii. 74; Beale, *Phil. Tr.* 1864, and *How &c.*; Hartmann, *Müller's Archiv*, 1863; Klein and Verson, *Stricker's Hist.* v. 1; Butlin, *St. Barth. Hosp. Rep.* 1879, 37.

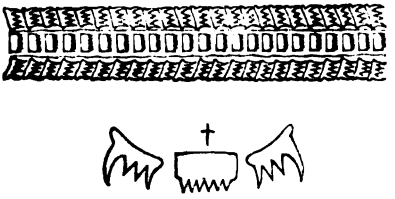
TONGUE OF MOLLUSCA.—The tongue, odontophore, or palate of the Mollusca, has long formed an interesting microscopic object on account of the elegant horny or chitinous teeth situated upon it, in numerous rows and in various patterns.

The tongue forms a shorter or longer ribbon-like structure, attached behind to the bottom of a sac or sheath, situated on the lower wall of the pharynx. It is supported by a cartilaginous cushion, over which it works backwards and forwards by muscular action.

It exists in the Gasteropoda, the Pteropoda, and the Cephalopoda.

It consists of a central strip or band, called the rachis, and two lateral bands, the

Fig. 755*.



Tongue of Whelk; with separate teeth †. Magnified 10 diameters, the teeth 40 diameters.

pleuræ. In the rachis, the teeth often rather resemble overlapping toothed plates, the teeth being straight, while the pleural teeth, or uncini of the lateral bands, are usually curved and more or less serrate.

Fig. 755**.

Row of teeth of the tongue of the Periwinkle. Magnified 120 diameters.

They may be easily examined in the limpet (*Patella*), the whelk (*Buccinum*), or in the freshwater snails, *Lymnæus*, *Planorbis*, &c.

In the tongue of many terrestrial Gasteropoda, as the snail (*Helix*) and slug (*Limax*), the number of plates in each row is very considerable, amounting to 180 in the large garden-slug (*Limax maximus*); whilst in many marine Gasteropoda, such as the common whelk (*Buccinum undatum*), the tongue has only three plates in each row, one bearing the small central teeth, and the two others the large lateral teeth. Generally speaking, the tongue of the terrestrial Gasteropoda is short, and contained within the nearly globular head; but the closely-set rows of teeth are usually very numerous, frequently more than 100, and in some species as many as 160 or 170; so that the total number of teeth may mount up, as in *Helix pomatia*, to 21,000, and in *Limax maximus* to 26,800. The transverse rows are usually more or less curved, whilst the longitudinal rows are quite straight; and the curvature arises on each side from the central longitudinal row, the teeth of which are symmetrical; whilst in those of the lateral portions of each transverse row, the prominences on the inner side of each tooth being suppressed, those on the outer side are increased, this modification augmenting in degree as we pass from the central line towards the edges. The tongue of the marine Gasteropoda is generally longer, and its teeth larger; and in many instances it extends far beyond the head, which may, indeed, contain but a small part of it. Thus in the common limpet (*Patella*) the principal part of the tongue is folded up, but perfectly free, in the abdominal cavity, between the intestines and the muscular foot; and in some species its length is twice or even three times as great as that of the entire animal. In a large proportion of cases the tongue exhibits a very marked separation between the central and the lateral portions —the teeth of the central band being frequently small and smooth at their edges, whilst those of the lateral are large and serrated. The tongue of *Trochus zizyphinus* is one of the most beautiful examples of this form—not only the large teeth of the lateral bands, but the delicate leaf-like teeth of the central portion having their edges minutely serrated. A yet more complex type is found in the tongue of *Haliotis*, in which the central band of teeth has nearly straight edges instead of points, with on each side a lateral band consisting of large teeth shaped like those of the shark, and beyond this, again, another lateral band on either side, composed of several rows of smaller teeth. Very curious differences also present themselves among the different species of the same genus. Thus in *Doris pilosa* the central band is almost entirely wanting, and each lateral band is formed of a single row of very large hooked teeth, set obliquely: whilst in *Doris tuberculata* the central band is most developed, and contains a number of rows of perpendicularly conical teeth, like those of a harrow. In *Dendronotus*, the central and lateral teeth are very finely and beautifully serrated.

In *Littorina*, the periwinkle, the tongue is 2½ inches long, coiled like a watch-spring, and contains about 600 rows of teeth.

The tongues may be preserved either in the dry state, or in glycerine or in balsam.

many of them in the latter medium forming beautiful polarizing objects.

The imperfectly cleansed tongues, when stained with Judson's dyes, also form beautiful objects.

BIBL. Carpenter, *Microscope*; Thomson, *Todd's Cycl. An. & Phys.* iv. 1142; *Ann. N. H.* 2. vii. 86; Gray, *ib.* 2. x. 413; Macdonald, *ib.* 1868, ii. 236, 1869, iii. 113; Maplestone, *Mn. Mic. Jn.* 1872, 45; Hogg, *Tr. Mic. Soc.* 1868; Lovén, *Œfversigt Kongl. Vetensk. Ak. Förhandl.* 1847; Troschel, *Gebiss d. Schnecken* (36 pls.), 1875; Woodward, *Mollusca.*

TONSILS.—These organs may be regarded as consisting of from ten to twenty follicular glands, resembling those found at the root of the tongue, surrounded by a common fibrous coat or capsule.

The blood-vessels are numerous, forming elegant networks around the follicles. (Kölliker, *Hist.*; Klein & Verson, *Stricker's Hist.*)

TOPAZ.—The crystals of this mineral consist principally of silicate of alumina, with the fluorides of aluminium and silicium.

Sections of topaz &c. often exhibit microscopic cavities, frequently containing crystals and one or two non-miscible liquids, the latter sometimes including bubbles of gas or vapour.

Brewster recommended the spherical cavities as the best objects for examining the aberrations of lenses, and as infinitely preferable to globules of mercury.

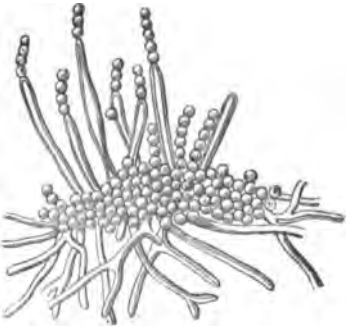
BIBL. Brewster, *Edinb. Phil. Tr.* x. & xvi.; *Microscope*, 186.

TORQUATEL'LA, Lankester. — A doubtful genus of Infusoria. Body rounded, with an anterior funnel-shaped frill of undulating membrane; no cilia, vacuoles, or nucleus. Marine, in Bay of Naples. (Lankester, *Qu. Mic. Jn.* 1874, 272.)

TOR'TULA, Hedw. See BARBULA.

TOR'ULA, Pers.—A genus of Torulacei. The plants ordinarily referred here appear to be somewhat heterogeneous in their nature. In what may be considered the true species, the chains of spores form the principal bulk of the plants, little or no filamentous mycelium existing. Other forms very generally included under this head agree in their characters with OIDIUM, which itself is a doubtful genus, probably founded on the conidiiferous states of more perfect kinds. But in *T. sacchari* (or *cerevisiæ*), the Yeast-fungus, usually referred here, we find both forms presented; for when actively vegetating in fermenting liquids, it presents the characters shown in Pl. 26. fig. 23, while, while the liquid becomes exhausted, portions of the fungus float to the top, and produce a filamentous structure, terminating in chains of spores, such as are represented in Pl. 26. fig. 24, and in fig. 756. The simply beaded form is taken as the type of a genus *Cryptococcus* by certain authors, some of whom consider it a Fungus, others

Fig. 756.



Torula sacchari (aërial form). Magnified 200 diameters.

(Kützing especially) an Alga. The same varieties of form occur in the Vinegar-plant; and in both cases *Penicillium glaucum* seems invariably to succeed the preceding when kept at a moderate temperature. Thus between all these various forms, together with *Oidium lactis*, there appears to be a relation, not yet clearly made out, indicating that they probably represent different states of the same plant growing under different conditions of nutrition and temperature. Further remarks on this head are made under YEAST and VINEGAR-PLANT. A growth similar to *T. sacchari* presents itself sometimes in decomposing urine (Pl. 26. fig. 7) from healthy subjects; and indeed scarcely any decomposing animal or vegetable fluid, in which there exist fermentible elements, remains long free from *Torula*-like growths, if left exposed to the air (see FERMENTATION).

We find it impossible to give definite characters for the species that have been enumerated. *T. herbarum* is a common form growing on decaying stems of plants;

it forms at first erect greenish tufts, which afterwards become blackish, ramify and form a black crust, the spores readily separating. *T. Sporendonema*, a form growing on decaying cheese, represents the *Sporendonema casei* of Desmazières. *T. Fumago* is now separated with other forms under the genus CAPNODIUM. *T. alternata* also is the type of the genus ALTERNARIA.

BIBL. Berk. *Br. Fl.* ii. pt. 2. 359; *Ann. N. H.* i. 263, vi. 439; 2. v. 460, xiii. 460; Fries, *Syst. Myc.* iii. 499; *Sum. Veget.* 505; Fresenius, *Beitr. z. Myc.* Heft ii. 58, pl. 6. fig. 55; Corda, *Ic. Fungorum.*

TORULA'CEI.—A family of Coniomycetous Fungi, forming moulds and mildews on decaying vegetable substances, or acting as ferments in decomposing vegetable and animal fluids. They are compound microscopic

Fig. 757.

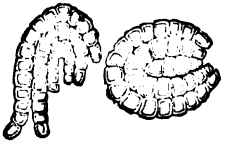


Fig. 759.

Fig. 758.

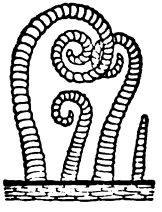


Fig. 757. Speira toruloides. Magnified 200 diameters.
Fig. 758. Gyrocerus ammonis. Magnified 200 diams.
Fig. 759. Trimmatostroma salicis. Magn. 200 diams.

cylindrical or beaded filaments, simple or ramified, the joints of which (all or part) separate from each other to form the spores. There is no definite receptacle here; the mycelium grows as a cottony web over or in the infected body, or forms clouds or flocks in liquids. Much obscurity prevails respecting the genera included below, and it is indeed doubtful whether any of them are independent productions. Some species of *Torula*, such as *T. cerevisiæ* (the Yeast-fungus), appear intimately connected with certain Hyphomycetous genera, perhaps merely representing their conidiiferous forms (see TORULA). ACHORION, again, seems to be merely the spermogonous form of a *Penicillium*. *Sporendonema* is founded apparently on imperfect observation; *S. muscæ*, the true characters of which are given under that head, has been renamed *Empusa*; and its proper position is among the Saprolegnei; but it would appear to be referable to the Mucorini. *Dictyosporium*, *Speira*, and *Trimmatostroma* appear to consist merely of the spores of some other genera; *Gyrocerus* cannot be regarded as a perfect form; and indeed all the genera require a thorough examination in a fresh state.

Synopsis of Genera.

Torula. Spores in beaded chains, simple, readily separating, placed on a short continuous or septate pedicel (Pl. 26. figs. 7 & 23).

Bispora. Resembling the last, but the spores uniseptate.

Septonema. Resembling the preceding, but having several transverse septa in the spores.

Alternaria. Resembling the preceding, but with cellular spores connected by a filiform isthmus.

Sporidesmium. Spores in tufts, straight, subclavate or fusiform, shortly stalked or sessile, transversely septate or cellular.

Tetraploa. Spores sessile, quadriseptate, coherent in bundles of four, each spore crowned with a bristle.

Sporochisma. Filaments erect, simple, external membrane inarticulate, cell-contents at length separating into spores, articulated in fours, emerging.

Coniothecium. Spores without septa, collected in heaps, finally separating more or less into a powder.

Echinobotryum. Spores rounded-apiculate, collected in fascicles, attached on simple, erect, annulated filaments.

Spilocæa. Spores globose, simple, adhering firmly together and to the matrix, forming spots laid bare by the separation of the epidermis of the subject infected.

Sporendonema. Described as composed of erect filaments, containing single rows of spores in the interior. *S. muscæ* (*Empusa*, Cohn) really consists of short, tufted, erect, simple filaments, terminating in a bell-shaped cell (spore or sporange?), thrown off with elasticity when mature.

Achorion. Mycelium somewhat ramose, articulated, joints terminating in round, oval, or irregular spores (conidia ?).

Speira. Spores connate into concentric filaments, forming laminæ resembling a horseshoe, finally separating.

Trimmatostroma. Spores more or less curved, multiseptate, chained in beaded rows, finally separating.

Gyrocerus. Spores connate into spirally coiled filaments, finally separating.

Dictyosporium. Spores tongue-shaped, reticularly cellular (fig. 172, p. 260).

TOURMALINE.—Sections of the crystals of this mineral, cut parallel to the axis, were formerly used as polarizers or analyzers. They are now usually replaced by Nicol's prisms (INTRODUCTION, p. xx). Crystals of the quinine-salt (QUININE) form cheap substitutes for either. The crystals of tourmaline belong to the rhombohedric system. They consist principally of silica with alumina, containing also boracic acid, magnesia, iron, &c.; but their composition is not constant.

Good tourmalines are transparent, brownish or pinkish; the colourless ones do not polarize.

BIBL. Pereira, *Polarized Light*; Naumann, *Mineralogie*, 319.

TOUS-LES-MOIS.—A kind of fecula consisting of the starch of species of *Canna*, remarkable for the large size, great transparency, and numerous striæ of the granules (Pl. 46. fig. 25). The mixture of any of the common kinds of starch with *Tous-les-mois* is readily detected by microscopic examination. The granules are excellent subjects for studying the physical characters of starch, in particular the appearance with polarized light (Pl. 39. fig. 40), &c. See STARCH.

TOXONIDEA, Donkin.—A proposed new genus of Diatomaceæ, the frustules of which resemble those of *Pleurosigma*, except that the longitudinal line is curved on each side of the median nodule in the same direction, so as to resemble a bow. Two species.

T. Gregoriana (Pl. 51. fig. 24).

BIBL. Donkin, *Micr. Jn.* 1858, vi. 12; Rabenht. *Alg.* i. 243.

TRACHE'A. See LUNGS.

TRACHE'Æ OF INSECTS, &c.—The respiratory tubes of Insects and Arachnida.

Tracheæ (Pl. 34. fig. 17; Pl. 35. fig. 2 *h*) are cylindrical tubes containing air. They are broadest at their origin from the spiracles, afterwards branching freely, the minute branches being distributed to all parts of the body and anastomosing freely. By reflected light they appear white, with a metallic lustre, or slightly iridescent; by transmitted light the smaller ones are black, the larger usually of a violet tint.

The tracheæ consist of two coats, between which lies a spiral fibre (Pl. 34. fig. 17): in the larger trunks a second external envelope exists. The fibre becomes more slender and indistinct in the smaller tracheal branches, until it finally disappears. The outer membrane appears to arise from the confluence of cells; for in the tracheæ of caterpillars and other larvæ of insects, the remaining nuclei are visible (Pl. 34. fig. 17). The inner coat forms a pavement epithelium. The spiral fibre arises from the splitting up of a homogeneous membrane deposited in the space bounded by the confluent cells of the outer membrane.

In many insects the tracheæ are furnished with dilatations forming air-sacs, in which the spiral fibre is absent.

When larvæ are fed with indigo or carmine, or when the dorsal vessel is injected with colouring-matter, the tracheæ become coloured, which some authors believe to arise from the nutritive liquid circulating between the membranes of the tracheæ; whilst by others this circulation, or the existence of a space between the tracheal membranes, is denied.

BIBL. That of INSECTS: Newport, *Phil. Tr.* 1836, 529; Platner, *Müller's Archiv*, 1844, xxxviii.; Stein, *Vergl. Anat. Insekten*; Agassiz, *Ann. Sc. Nat.* 3. xv.; Bassy, *ibid.*; Joly, *ibid.* xii.; Blanchard, *Compt. Rend.* 1851; *Ann. N. H.* 1852, ix. 74; Dufour, *Compt. Rend.* 1851, *Ann. N. H.* 1852, ix. 435; Meyer, *Siebold & Kölliker's Zeitschr.* i. 175; Moseley, *Proc. Roy. Soc.* No. 153. vol. xxii. 344, 1874; Gerstäcker, *Siebold & Kölliker's Zeitschr.* ii. 204, 1874; Landois, *Zeit. wiss. Zool.* xvii.

TRACHEÆ OF PLANTS.—This name was formerly applied to the unrollable SPIRAL Vessels of Plants, from their resemblance to the tracheæ of Insects.

TRACHELI'NA.—A family of Holotrichous Infusoria.

Char. Body without regular spiral teeth or foot; parenchyma excessively contractile; mouth and œsophagus very dilatable.

BIBL. Clap. & Lachm. *Inf.* p. 291.

Synopsis of Genera.

- TRACHELINA.
  - Mouth terminal.
    - Anterior part of body with a conical appendage.
      - Body more or less cylindrical, moving by turning on axis.
        - Mouth on the summit of the appendage..... *Lacrymaria.*
        - Mouth at its base ..... *Phialina.*
      - Body flat, swims without turning on axis ..... *Trachelophyllum.*
    - No conical appendage.
      - No internal teeth.
        - No leaping cirri.
          - Body attenuate in front *Enchelys.*
          - Body not attenuate in front ..... *Holophrya.*
        - Leaping cirri ..... *Urotricha.*
      - Internal teeth .....
        - Body attenuate in front *Enchelyodon.*
        - Body not attenuate in front ..... *Prorodon.*
  - Mouth not terminal.
    - Œsophageal teeth present.
      - No cirri ...
        - Body never much flattened..... *Nassula.*
        - Body much flattened..... *Chilodon.*
      - A bundle of cirri, simulating a foot..... *Trichopus.*
      - A row of spherical vesicles, each enclosing a very refractive body ..... *Loxodes.*
    - No œsophageal teeth.
      - No vesicles
        - No lamina.
          - A branched intestine... *Trachelius.*
          - No branched intestine. *Amphileptus.*
        - A broad marginal lamina of compact tissue ..... *Loxophyllum.*

TRACHE'LIUS, Ehrenb.—A genus of Holotrichous Infusoria, fam. Trachelina.

Char. Mouth situated at the base of the trunk-like prolongation, alimentary canal apparently branched. No row of spherical vesicles or lateral lamina.

T. ovum (*Amphileptus ovum*, Duj.), in bog-water. *Trachelius lamella* (Pl. 32. fig. 5) is a *Loxophyllum*. (Clap. & Lachm. *Inf.* 345.)

TRACHELOCER'CA, Ehr.—A genus of Holotrichous Infusoria = *Lacrymaria*.

T. olor = *Lacrymaria olor*.

T. viridis (Pl. 31. fig. 33). Body green; neck as in the last; freshw.; length 1-120″.

Bibl. Ehr. *Inf.* 341; Clap. & Lachm. *Inf.* 295; Kent, *Inf.* 514.

TRACHELOMO'NAS, Ehr.—A genus of Infusoria, family Cryptomonadina.

Char. Body enclosed in a spherical or ovoid hard and brittle envelope, having a small aperture, from which a long flagelliform filament projects; eye-spot present. Freshwater.

T. volvocina (Pl. 30. fig. 24 *d*, empty envelope). Spherical, green, brownish, or red; eye-spot red; length 1-865″.

T. nigricans. Ovate-globose, green, blackish brown or reddish; eye-spot brownish; length 1-1730″.

T. cylindrica. Oblong-subcylindrical; bright green; eye-spot red; length 1-1000″.

Other species.

The bodies represented in Pl. 30. fig. 24 (*b* to *g*), and which are commonly found in bog-water, probably belong here, with the genera *Chætoglena* (*a*), *Chætotyphla* (fig. 26), and *Doxococcus* (fig. 47). The margins of the red envelope appear as a bright red ring, on account of the greater thickness traversed by the light. They are probably spores of Algæ.

Bibl. Ehrenberg, *Inf.* 47; Kent, *Inf.* 388.

TRACHELOPHYL'LUM, Clap. & Lach. —A genus of Trachelina (Holotrichous Infusoria).

Char. Anterior part of the body with a prolonged appendage, which has no circlet of cirri; body flat, without a lateral marginal lobe. Swims without turning on its axis. Two species; freshwater. (Clap. & Lachm. *Inf.* 306.)

TRACHYL'IA, Fr.—A genus of Microlichens, parasitic on *Pertusariæ*.

Char. Thallus granular; apothecia cupuliform, sessile, black. Spores blackish, 1-septate. Three species, on old posts. (Lindsay, *Qu. Mic. Jn.* 1869, 146; Leighton, *Lich. Fl.* 47.)

TRACH'YTE. See Rocks.

TRADESCANTIA, L.—A genus of Commelynaceæ (Monocotyledons), commonly cultivated in gardens under the name of Spider-worts. These plants are celebrated for having served as material for some of the most remarkable observations on the physiological processes of vegetables —as the Rotation of the cell-contents, and the multiplication of the cells, so well seen in the hairs of the stamens when young (Pl. 47. figs. 8 & 9). The stems, petioles, &c. afford beautiful spiral, annular, and reticulated vessels, &c.

TRAG'ACANTH.—A gum derived from various species of *Astragalus*, not consisting of a formless exudation, but of partly disorganized collenchymatous tissue which is extruded from the medullary rays. It is often used for fastening opaque objects, as, when dry, its surface is dull, unlike gum-

arabic. We have some of the solution which has been kept twelve years in a corked bottle with a piece of camphor, and it is as good as if freshly prepared.

TRE'BIUS, Kröyer.—A genus of Crustacea, order Siphonostoma, family Caligidæ.

Char. Head in the form of a large buckler, with the large frontal plates destitute of sucking-disks; thorax three-jointed, segments uncovered; legs four pairs, with long plumose hairs, fourth pair slender and two-branched; antennæ small, flat, and two-jointed; second pair of foot-jaws two-jointed, and not in the form of a sucking-disk.

T. caudatus. Found upon the body of the skate. Male much smaller than the female.

BIBL. Baird, *Entomostraca*, 280; Thompson, *Ann. N. H.* 1847, xx. 248.

TREMATO'DA.—An order of Entozoa, containing the flukes. See DISTOMA.

TREMELLI'NI.—A family of Hymenomycetous Fungi, consisting of polymorphous, often convoluted or lobed, more or less gelatinous masses, growing upon branches or stumps of trees, in crevices of the bark, or on the dead wood. The hymenium extends over the whole of the upper exposed surface, and, from the recent researches of Tulasne, appears to present remarkable characters. The gelatinous substance of these Fungi is composed of ramified filaments, with more or less effused mucilage between them. In *Tremella* a portion of the filaments terminate at the surface at first in expanded globular cells (Pl. 27. figs. 3, 4), which become divided by vertical septa into four somewhat pyriform cells (*basidia*); from each of these arises a slender filament (*sterigma*), which terminates in a slender point tipped with a globular spore (*stylospore* or *basidiospore*). Other filaments coming to the surface in like manner ramify extensively, with short divergent branches, finally bearing numerous minute globular bodies (*spermatia*), solitary or in groups of four, which, like the basidiospores, fall off and rest on the hymenial surface, involved in jelly, but, unlike those, do not germinate. The basidiospores are about 1-3000″ in diameter, the spermatia about 1-12000″. In *Tremella mesenterica* the surface covered with basidiospores assumes a whitish colour, the layers of spermatia and the jelly are orange.

In *Exidia* the production of the basidiospores is similar; but the spores are reniform and unilocular, about 1-2500″ long and 1-5000″ in diameter. Spermatia have not been detected.

In *Dacrymyces* the basidia are represented by simple clavate or bifurcate branches at the hymenial surface, these terminating in points bearing single reniform spores exhibiting three septa (quadrilocular). In germination some of these spores produce a long filament from each loculus; others behave differently, producing the *spermatia* of the plant, each loculus sending out a short pointed process bearing a globular cellule exactly resembling the spermatia of *Tremella*. Other examples of *Dacrymyces* bear a different kind of reproductive bodies, apparently representing *conidia*. In these the peripheral filaments terminate in a mass of many-jointed *Torula*-like processes, which ultimately break up into the separate joints. (See DACRYMYCES.)

BIBL. Berk. *Br. Fl.* ii. pt. 2. 215; *Ann. N. H.* 2. xiii. 406, pl. 15. fig. 4; Tulasne, *Ann. Sc. Nat.* 3. xix. 193, pls. 10–12.

TRENTEPOH'LIA, Mart. = *Chantransia* and *Chroolepus* sp.

TREPOM'ONAS, Duj.—A genus of Flagellate Infusoria, family Monadina.

Char. Body compressed, thicker and rounded behind, twisted in front into two narrowed lobes, which are inflexed laterally, and each terminated by a flagelliform filament, which produces a very lively rotatory and jerking motion.

T. agilis (Pl. 32. fig. 6). Body granular, unequal; length 1-1160″. In decomposing marsh-water. (Dujardin, *Infus.* 294; Kent, *Inf.* 300.)

TRIAR'THRA, Ehr.—A genus of Rotatoria, of the family Hydatinæa.

Char. Eyes two, frontal; foot simply styliform; body with lateral cirri or fins. Movement jerking. Jaws two; each bidentate.

T. longiseta (Pl. 44. fig. 30). Eyes distant, cirri and foot nearly three times as long as the body; length 1-216″.

T. mystacina. Eyes approximate; cirri and foot scarcely twice as long as the body.

T. breviseta (Gosse). Cirri much shorter than the body.

BIBL. Ehr. *Inf.* 446; Gosse, *Ann. N. H.* 1851, viii. 200; Pritchard, *Infus.*

TRICERA'TIUM, Ehr.—A genus of Diatomaceæ.

Char. Frustules free; valves triangular, areolar, each angle mostly with a minute tooth or short horn.

T. favus (Pl. 17. fig. 29). Valves plane or convex, angles obtuse, with horn-like processes; areolæ hexagonal; marine; diameter 1-240″.

T. alternans. Angles of valves slightly elevated; areolæ circular; marine.

T. striolatum (?). Angles subacute; areolation faint; brackish water.

Bibl. Ehr. *Ber. Berl. Ak.* 1840; Smith, *Br. Diat.* i. 26; Kütz. *Bacill.* 138, and *Sp. Alg.* 139; Brightwell, *Micr. Jn.* 1858, 153; Rabenht. *Alg.* i. 315.

TRIC'HIA, Hall.—A genus of Myxomycetes (Gasteromycetous Fungi) growing upon rotten wood &c., characterized by a stalked or sessile, simple, membranous peridium, which bursts at the summit, whence the densely interwoven free capillitium expands elastically, carrying with it the spores. The capillitium is composed of tubular filaments (*elaters*), containing spiral-fibrous secondary deposits, like the elaters of *Marchantia* (Pl. 40. fig. 39). In some species the elaters bear numerous little spinulose processes. The genus is divisible into two groups. In the first (*Hemiarcyria*) the dehiscence of the peridium is obscurely circumscissile (fig. 760), the capillitium dense; these are always stalked, usually of reddish colour when young. Some species have the peridia fasciculate on a compound peduncle (fig. 760), others separate. In the other division (*Goniospora*) the dehiscence of the peridium is irregular, the capillitium lax, the peduncle short or absent, the colour at

Fig. 760.

Trichia rubiformis.
Magnified 25 diameters.

first whitish, changing to yellow, and the spores rather angular. In *T. serpula* and *reticulata* the sessile peridia are irregular, flexuous, serpentine or annular bodies; in most of the other species the peridia are pyriform, turbinate, or of some analogous form. The elaters (Pl. 40. figs. 39 & 40) are interesting objects, and form good tests for the defining-power of the microscope under very high powers. They must be mounted in a very thin stratum of liquid.

Bibl. Berk. *Br. Fl.* ii. pt. 2. 319; *Ann. N. H.* vi. 432, 2. v. 367; Fries, *Syst. Myc.* iii. 182; *Sum. Veg.* 457; Greville, *Crypt. Fl.* pls. 266, 281; Henfrey, *Linn. Tr.* xxi. 221; Currey, *Mic. Jn.* iii, 15, v. 127.

TRIC'HINA, Owen.—A genus of Nematoid Entozoa.

T. spiralis (Pl. 21. figs. 16, 17, 18), as ordinarily seen, inhabits the human body, forming opaque white specks, visible to the naked eye, in the voluntary muscles. The worms usually exist singly within a cyst situated between the muscular bundles (fig. 16). At each end of the cyst is a group of fat-cells resembling those of ordinary fatty tissue. The cysts are about 1-50″ in length, elliptical or oval, usually narrowed and slightly produced at the obtuse ends, and consist of numerous structureless laminæ, in which are frequently imbedded minute granules consisting of fatty or calcareous matter. The worm is cylindrical, narrowed towards the anterior end, the posterior end being obtuse and rounded. The integument is transversely striated or annular, and exhibits an anterior and a posterior longitudinal muscular band. The mouth (fig. 17 *a*) is situated at the anterior extremity, from which a small papilla is sometimes protruded. The first part of the alimentary canal is very narrow, and leads to a broader sacculated portion; this behind the commencement of the posterior half of the body terminates in a funnel-shaped expansion (fig. 18 *c*), the remainder of the canal being narrow and lined with pavement epithelium (fig. 18 *d*). The manner in which the posterior end of the alimentary canal terminates is doubtful—whether directly continuous with the anal orifice, or free in the abdominal cavity. Luschka describes three valves as existing at the posterior end of the body. At the commencement of the funnel-shaped portion of the alimentary canal (fig. 16 *b*) are two rounded glandular sacs. The reproductive organs are not well known. Just below the funnel-shaped portion of the alimentary canal is the cæcal origin of a tubular sac (figs. 17 & 18 *e*), containing a dark granular-looking body (fig. 17 *d*; fig. 18 *e*) near its commencement; this extends to the posterior end of the worm, where it either terminates in the anus or in the

abdominal cavity. Luschka regards this as the male organ, and the dark-looking body as the testis; but no spermatozoa have been detected.

Some of the cysts and worms are found in a state of fatty degeneration, with granules or globules of fat, and calcareous matter.

Trichina is admitted to the human body with the food. It exists in two different conditions. In one it is sexually immature; and it then inhabits the muscles, of the pig or rabbit for instance, in vast numbers, each worm being coiled up in its capsule or cyst. It is incapable of further development under these circumstances. But if a portion of the muscle be eaten by a warm-blooded vertebrate animal and so introduced into the alimentary canal, the immediate development of young *Trichinæ* is the result. The immature worms escape from the cysts, grow larger, develop sexual organs, and produce viviparously a numerous progeny. The young *Trichinæ* thus produced perforate the walls of the digestive system, and after working into the muscles become encysted.

It is important that every one should know the appearance of meat infected with this worm, as it produces serious disease, and even death. It is stated that 8 per cent. of the slaughtered American pigs contain *Trichinæ*.

Three or four other doubtful species have been described.

Bibl. Owen, *Zool. Tr.* i. 315; Luschka, *Siebold & Köll. Zeitschr.* iii. 69; Bristowe and Rainey, *Tr. Path. Soc.* v. 274; Duj. *Helminthes*, 293; Herbst, *Ann. Sc. Nat.* 3. xvii.; Kobelt, *Valentin's Rep.* 1841; Leuckart, *Par.*; Bakody, *Sieb. & Köll. Zeit.* 1872, 422; Virchow, *Qu. Mic. Jn.* 1861, 44; Cobbold, *Parasit.* 149; and the Bibl. of Entozoa.

TRICHOCEPH'ALUS, Goeze.—A genus of Nematoid Entozoa.

Char. Body elongate, composed of two parts, the anterior longer and capillary, the posterior becoming suddenly broader; spiculum of male simple, long, and surrounded by a sheath.

The species occur in the large intestine, principally the cæcum of man and the mammalia.

T. dispar (Pl. 21. fig. 19, the male; fig. 21, the female).

Anterior portion of the body, spiral in the male, containing the œsophagus only, or the first moniliform portion of the intestine; posterior portion containing the rest of the intestine and the reproductive organs. Anus situated at the posterior obtuse end of the body. Integument transversely striated, and with a longitudinal band studded with papillæ (Pl. 21. fig. 20). Oviduct terminating at the point of junction of the two portions of the body; ova (fig. 21 *a*) oblong, covered by a resistant shell, with a short neck at each end.

Bibl. That of Entozoa.

TRICHOCO'LEA, Nees.—A genus of Jungermannieæ (Hepaticæ), containing one British species, *T.* (*Jung.*) *tomentella*, growing in moist places in the west and north of England, Scotland, and Ireland. It is remarkable for the character of the leaves, which are cut up into compound capillary segments, giving the plant a spongy texture. Colour pale.

Bibl. Hook. *Brit. Fl.* ii. pt. 1. 127; *Br. Jung.* pl. 36; Ekart, *Synops. Jung.* pl. 6. fig. 49; Endlicher, *Gen. Plant.* Supp. 1. no. 472, 15.

TRICHO'DA, Müll.—A genus of Holotrichous Infusoria.

Char. Free, ovate or club-shaped, truncate in front; mouth anterior, with a lip or vibratile membrane; cilia very fine, oral larger.

T. pura, oblong attenuate in front; in putrid infusions, of hay &c.; length 1-720″.

T. carnium, in putrid-flesh water.

T. pyrum, in pond water.

T. angulata, Duj. (Pl. 32. fig. 7), oblong, obliquely and irregularly folded or angular, with one or more superficial vacuoles; freshwater; length 1-700″.

Bibl. Ehr. *Inf.* 306; Duj. *Inf.* 395.

TRICHODAC'TYLUS, Dufour.—A genus of Acarea (Acarina).

Rostrum short, with minute setæ; fourth pair of legs longer than the rest, without claws, but terminated by a very long seta.

T. Osmiæ. Glabrous, pale red, with two marginal setæ on each side; legs and posterior part of the body darker; length 1-50″.

T. Osmiæ, on an *Osmia*; *T. Xylocopæ*, on *Xylocope*; another species in hornets' nests.

Murray unites the three genera, *Hypopus*, *Trichodactylus*, and *Homopus* into a family, Hypopidæ; while Mégnin declares them to be the nymphæ of Acarea.

In all, the hinder pair of legs is rudimentary, hairs replacing claws.

Bibl. Dufour, *Ann. Sc. Nat.* 2. xi. 276; Gervais, *Walckenaer's Aptères*, iii. 266; Murray, *Ec. Ent.* 251; Mégnin, *Paras.* 146.

TRICHODEC'TES, Nitzsch.—A genus of Philopteridæ (Anoplura).

Char. Antennæ filiform, three-jointed; maxillary palpi none or inconspicuous; mandibles two-toothed; tarsi with one law.

T. latus (Pl. 35. fig. 6). Abdomen pale fulvous; head and thorax ferruginous yellow; head subquadrate, with two black spots in front, and a black lateral band on each side; abdomen oval.

Common upon dogs, especially puppies.

Other species, upon cattle, the horse, ass, deer, sheep, cat, &c.

BIBL. Denny, *Anoplur.* 186; Murray, *Ec. Ent.* 383; Mégnin, *Paras.* 80.

TRICHODER'MA, Pers.—A genus of Fungi, placed by Fries among the Gasteromycetes. The plants are characterized by a roundish peridium composed of interwoven, ramified, septate filaments, evanescent at the summit; the spores minute, heaped together, at first conglobated. *T. viride*, growing on fallen trees, has a white villous peridium, and dusky-green globose spores. The peridia appear as scattered spots 1-20 to 1-8″ or more in diameter. It is a conidiiferous state of *Hypocrea rufa*.

BIBL. Berk. *Br. Fl.* ii. pt. 2. 323; Greville, *Crypt. Fl.* pl. 271; Fries, *Sum. Veg.* 417.

TRICHODES'MIUM, Ehrenb.—A genus of microscopic Algæ, apparently belonging to the Nostochaceæ, discovered by Ehrenberg to produce the red colour over large tracts in the Red Sea, and found also in the Atlantic and Pacific Oceans by Darwin and Hinds, and in the Chinese Sea. No vesicular cells or spermatic cells have been detected; hence the characters are as yet imperfect. Montagne has separated the plant of Hinds from Ehrenberg's; and Kützing characterizes two species in his *Sp. Algarum*, and figures them in his *Tabulæ Phycologicæ*; but neither the figures nor the descriptions indicate any very marked differences.

T. Ehrenbergii, Montagne. Blood-red (at length becoming green); bundles widish, confluent; filaments 1-3000″ in diameter, joints about twice as wide as long. Found floating in vast strata in the Red Sea by Ehrenberg and Dupont, and in the Yellow Sea (China).

T. Hindsii. Blood-red, with a strong odour; bundles longish, slender; joints twice or thrice as broad as long, transversely granulated.

See also on the species, and on the red coloration of the sea by plants, Montagne's papers in the *Ann. Sc. Nat.* 3. ii. 332, vi. 262; 4. i. 81; *Ann. N. H.* 2. xix. 431; Rabenht. *Alg.* ii. 161.

TRICHODI'NA, Ehr.—A genus of Peritrichous Infusoria, family Vorticellina.

Char. No tail, nor pedicle; cilia absent from the surface of the conical or discoidal body, but forming a frontal crown or a tuft; oral orifice not spiral.

T. pediculus (*Urceolaria stellina*, D.) (Pl. 31. fig. 16). Body discoidal, the under and upper surfaces each with a crown of cilia. Parasitic upon *Hydra vulgaris* and *viridis*. Breadth 1-575 to 1-200″. On the under surface is an annular undulatory membrane; and within and at the base of this is a horny ring, with an outer and an inner row of teeth, forming an organ of adhesion.

T. mitra. Parasitic upon *Planaria torva*.

T. grandinella and *T. vorax*, on Halterina.

T. tentaculata. Body discoidal, cilia large, forming a tuft; a styliform, tentacle-like process present; diam. 1-290″.

BIBL. Ehrenberg, *Inf.* 265; Dujardin, *Inf.* 527; Siebold, *Siebold und Kölliker's Zeitschr.* ii. 361; Stein, *Inf.* 174; Claparède & Lachmann, *Inf.* 128; Kent, *Inf.* 647.

TRICHODINOP'SIS, Cl. and Lachm.—A genus of Heterotrichous Infusoria. Free, conical; an anterior oral ring of cilia, and a posterior suctorial disk. *T. paradoxa*, in the mucous cavities of *Cyclostoma*. (Clap. & Lachm. *Inf.* 133; Kent, *Inf.* 614.)

TRICHODIS'CUS, Ehr.—A genus of Rhizopoda, family Actinophryina, D.

Char. Body depressed, stalkless; setaceous tentacles forming a simple row at the margin of the body.

T. sol (Pl. 32. fig. 8). Body suborbicular, hyaline or yellowish, tentacles variable; diameter 1-432 to 1-216″.

BIBL. Ehr. *Inf.* 304.

TRICHOGAS'TER, Sterki.—A genus of Hypotrichous Infusoria. Free, ovate, ventral surface ciliated, a few larger cilia in front and behind. *T. pilosus*, freshwater. (Sterki, *Zeits. wiss. Zool.* 1878; Kent. *Inf.* 764.)

TRICHOGAS'TRES (*Puff-balls*).—A family of Gasteromycetous Fungi, characterized by the contents of the leathery peridium breaking up when mature into a pulverulent mass of spores and filaments, without a central column, the whole being expelled by the bursting of the case (see GASTEROMYCETES).

BIBL. Berkley, *Ann. N. H.* iv. 155; Tulasne, *Ann. Sc. N.* 2. xvii. 1.

TRICHOM'ANES, Linn.—A genus of Hymenophyllaceous Ferns, of elegant and delicate habit.

Fig. 761. Fig 762.

Trichomanes alatum.

Fig. 761. A pinnule. Magnified 5 diameters.

Fig. 762. Section through a sorus, showing the vein prolonged as a columella, and continued out beyond the border. Magnified 25 diameters.

Fig. 763.

A sporange, with horizontal annulus. Magnified 100 diameters.

Many species; tropical. *T. brevisetum* (*radicans*), British. (Hooker, *Syn.* 79.)

TRICHOM'ONAS, Donné.—A genus of Flagellate Infusoria.

Char. Free, soft, ovate, with two anterior and one posterior flagella, and a dentate lateral undulating membrane; no mouth.

T. batrachorum, in the intestine of frog and toad.

T. vaginalis (Pl. 32. fig. 9). Body glutinous, nodular, unequal, frequently becoming agglutinated to other objects; movement vacillating; length 1-2500″. Found in morbid vaginal mucus.

T. limacis (Pl. 32. fig. 10). Body ovoid, smooth, pointed at each end; movement forwards, by revolution upon its axis; length 1-1600″. Found in the intestine of *Limax agrestis*.

Bibl. Dujardin, *Infus.* 290; Kent, *Inf.* 308.

TRICHONE'MA, From.—A genus of Cilio-Flagellate Infusoria. Free, ovate, variable; flagellum single; body with short cilia. *T. hirsuta*; freshwater. (Kent, *Inf.* 469.)

TRICHONYM'PHA, Leidy.—A genus of Holotrichous Infusoria. *T. agilis*, in the intestine of the American white ant. (Leidy, *Proc. Ac. Philadelphia*, 1881; Kent, *Inf.* 533.)

TRICHOPH'RYA, Cl. & Lachm.—A genus of Acinetina. Like *Podophrya*, but fixed without a pedicle; tentacles in scattered bundles; vesicles numerous; nucleus band-like. Two species; on the stalk of *Epistylis plicatilis*, and on Entomostraca. (Cl. & Lachm. *Inf.* 386; Kent, *Inf.* 811.)

TRICHOPH'YTON. See Parasites.

TRIC'HOPUS, Clap. & Lach.—A genus of Hypotrichous Infusoria.

Char. Body depressed, with a bundle of long ventral cirri near the posterior end of the body; a tuft of caudal cilia, and a group of pharyngeal teeth.

T. dysteria; marine. (Claparède & Lachmann, *Inf.* 338.)

TRICHOR'MUS (*Anabæna*, Bory, Brébisson, Kützing, Montagne, &c.).—A genus of Nostochaceæ (Confervoid Algæ), growing on wet earth, and rising to the surface of lakes, brackish ditches, &c., forming an indeterminate stratum, at first nearly colourless and transparent, with the filaments sparingly scattered through the mass; the filaments afterwards increasing rapidly in number, causing the mass to become opaque; deep bluish green, and occasionally mottled with brown, especially beneath. Filaments mostly short and moniliform. Cells more or less globular; the spermatic cells resembling the ordinary cells more in this than in the allied genera. The filaments closely resemble those of *Nostoc*; and some of the floating aquatic species can only be distinguished from that genus by the absence of definite form or size, and of the hardened periderm. It differs from *Dolichospermum* in the globular shape of its sporangia, and from *Sphærozyga* and *Cylindrospermum* in the arrangement of its vesicular and spermatic cells, which are in *Trichormus* separated by ordinary cells. In Pl. 8. fig. 2, we have represented what appears to be a new species.

T. flos-aquæ. Filaments flexuous or curved, moniliform; cells orbicular, vesicular ones larger, terminal and interstitial. Ralfs, *Ann. N. H.* 2. v. pl. 8. fig. 2. *Anabaina fl.-aq.*, Kütz. *Sp. Alg.*; *Trichormus incurvatus*, Allman, *Ann. N. H.* xi. 163; Hassall, *Algæ*, pl. 75. Rising to the surface

of stagnant pools or other still waters, in gelatinous bluish or green masses.

T. spiralis. Filaments coiled or spiral; vesicular and spermatic cells orbicular. Ralfs, *l. c.* pl. 8. fig. 3 (?). *Anabaina spiralis*, Thompson, *Ann. N. H.* v. 81; *Spirillum Thompsoni*, Hassall, *Br. Fr. Algæ*, pl. 75.

T. Thwaitesii. Filaments moniliform, flexuous; ordinary cells globular or nearly so; vesicular cells larger, globular when interstitial, ovate when terminal, ciliated; sporangia oval, catenate. Ralfs, *l. c.* pl. 8. fig. 4. Salt marshes, forming thin, gelatinous dark-green patches, on damp soil or the bottom of ditches, then floating and abounding in spermatic cells.

T. oscillarioides. Filaments elongate, flexuous; ordinary joints subquadrate; vesicular cells barrel-shaped or elliptic, naked; spermatic cells oval, catenate. Ralfs, *l. c.* pl. 8. fig. 5. Bluish green, in brackish ditches.

T. rectus. Filaments bright green, straight. Ralfs, *l. c.* pl. 8. fig. 6; in pools.

BIBL. Ralfs, *Ann. N. H.* 2. v. pl. 8; Rabenht. *Alg.* ii. 293.

TRICHOSPHÆ'RA, Semper.—A genus of Rotifera. *T. æquatorialis* is spherical, the rotatory organ consisting of an equatorial zone of cilia; found among worms, infusoria, &c. in the rice-field ditches of Zamboanga; diameter 1-36." (Semper, *Sieb. & Köll. Zeitschr.* 1875, *Mn. M. Jn.* xiv. 237.)

TRICHOSPO'RIUM, Fr.—A genus of Mucedines (Hyphomycetous Fungi), nearly allied to BOTRYTIS, characterized by a cæspitose mycelium, whence arise fertile continuous filaments, bearing solitary, simple, acrogenous spores. *T. nigrum* = *Sporotrichum nigrum*, Fries (*Syst. Myc.*), *Botrytis nigra*, Link.

BIBL. Fries, *Sum. Veg.* 492; Grev. *Crypt. Fl.* pl. 274.

TRICHOSTOMUM, Hedw.—A genus of Pottiaceous Mosses, so called from the hair-like peristome, resembling closely that of BARBULA (*Tortula*), but with the teeth straight instead of twisted; in *T. rigidulum*, however (fig. 764), there exists a slight curling even in this genus. The *Trichostoma* grow on the ground and on stones.

Fig. 764.

Trichostomum rigidulum. Fragment of the peristome with filiform teeth. Magnified 100 diameters.

TRICHOTHE'CIUM, Link (*Diplosporium*, ejusd.).—A genus of Mucedines (Hyphomycetous Fungi), growing upon dead sticks, herbaceous parts of plants, &c., forming a cæspitose entangled mycelium, from which arise erect fertile filaments, bearing at the summit a few acrogenous, free, didymous spores. From some observations recently published by Hoffmann, and confirmed by Bail, the spores of *T. roseum*, when they germinate, produce a mycelium whence arise fertile filaments of *Verticillium ruberrimum*, the "spores" of which they consequently consider to be the *spermatia* of this plant. Several species are British, as *T. roseum*, *obovatum* (*Dactylium*, Berk.).

BIBL. Berk. *Br. Fl.* ii. pt. 2. 348; *Ann. N. H.* vi. 437, pl. 14; Greville, *Crypt. Fl.* pl. 172; Fries, *Sum. Veg.* 492; Hoffmann, *Bot. Zeit.* xii. 249; Bail, *ibid.* xiii. 673.

TRICHY'DRA, Wright.—A genus of Hydroid Zoophytes.

Char. Stem creeping, branched; cells rudimentary, consisting of very short tubular processes at intervals on the creeping stem; polypes cylindrical, very slender and extensile, with a short conical proboscis. *T. pudica*, marine, on shells &c. (Hincks, *Hyd. Zooph.* 215.)

TRILOCULI'NA, D'Orb.—A subgenus of *Miliola*, with the chambers aggregated on three opposite faces, embracing, three only apparent.

Many species, both recent and fossil. *M.* (*Tr.*) *trigonula* (Pl. 23. fig. 4).

BIBL. Williamson, *Rec. Brit. For.* 84 (*Miliolina*); Carpenter, *For.* 78.

TRIMAS'TIX, Kt.—A genus of Flagellate Infusoria. Free, ovate, with a lateral membranous border; flagella three, anterior, one directed forwards, the others trailing.

T. marina. In salt water with decaying plants; length 1-1400". (Kent, *Inf.* 312.)

TRIMMATOSTRO'MA, Corda (fig. 759, p. 774). An obscure genus of Torulacei (Coniomycetous Fungi), perhaps founded on the spores of *Phragmatotrichum*. (Corda, *Icon.*; Fries, *Sum. Veg.* 475.)

TRINA'CRIA, Heib.—A genus of Diatomaceæ.

Char. Frustules with three broad, bispined, equal-lengthed processes, margin pearly, angles naked. Danube.

BIBL. Rabenht. *Alg.* i. 317.

TRINE'MA, Duj.—A genus of Rhizopoda, family Actinophryina.

Char. Carapace membranous, diaphanous, elongate-ovoid, narrower in front, with a large oblique lateral orifice; expansions two or three, filiform, very slender, as long as the carapace.

T. acinus=*Diffiugia enchelys*, E. (Pl. 32. fig. 11, after Ehr. In Dujardin's figure the expansions are represented as much more slender.)

Bibl. Duj. *Inf.* 249; Clap. & Lach. *Inf.* 455.

TRINO'TON, Nitzsch=*Liotheum* pt.

TRIOPHTHAL'MUS, Ehr.—A genus of Rotatoria, of the family Hydatinæa.

Char. Eyes three, red, cervical, in a transverse row; foot forked; jaws single-toothed.

T. dorsalis (Pl. 44. fig. 31). Body crystalline, turgid, suddenly attenuated at the foot, which is half the length of the body. Length 1-48 to 1-36". (Ehrenberg, *Inf.* 450.)

TRIPHRAG'MIUM, Link.—A genus of Uredinei (Hypodermous Fungi), distinguished by their trilocular spores (fig. 765). *T. ulmariæ* (*Uredo ulmariæ*, *Brit. Fl.*) grows upon the leaves of *Spiræa ulmaria*, forming orange, subsequently blackish, effused patches, bursting from beneath the epidermis. Tulasne has shown that it possesses all three forms of reproductive structure of the Uredinei, viz. 1. spermogonia with *spermatia*; 2. *Uredo*-fruits, with ellipsoid or globose *stylospores*; and 3. perfect fruits, arising either among the stylospores or in special sori, containing stipitate three-lobed spores (fig. 765), each lobe of which is unilocular and exhibits a single pore in its black tubercular outer coat. The last germinate in the spring, and produce from each pore a tubular filament which becomes divided into four or five chambers, from three or four of which arise single styliform processes (*sterigmata*), each bearing a small smooth spherical sporidium. The globular stylospores also germinate (in the first summer), but produce only a long filiform process, probably the rudiment of a new mycelium. (See Uredinei.)

Fig. 765.

Triphragmium ulmariæ. A pedicellate spore. Magnified 350 diameters.

Bibl. Berk. *Br. Fl.* ii. pt. 2. 368; Tulasne, *Ann. Sc. Nat.* 4. ii. 181, pl. 10; Fries, *Sum. Veg.* 513; Currey, *Micr. Jn.* v. 126.

TRIPLO'CERAS, Bail.=*Docidium* sp.

TRIPOSPO'RIUM, Corda.—A genus of Dematiei (Hyphomycetous Fungi), characterized by the three-lobed septate spores. *T. elegans* (fig. 766) has been found in this country on bare oak-trunks. Another species, *T. Gardneri*, forms a blight in the coffee plantations of Ceylon.

Fig. 766.

Triposporium elegans. Magnified 200 diameters.

Bibl. Berk. *Ann. N. H.* 2. vii. 98; *Hortic. Jn.* iv. 8.

TRITAX'IA, Reuss. See Textularia. (Reuss, *Sitz. Ak. Wien*, xliv. 383.)

TRITICEL'LA, Dalyell.—A genus of Ctenostomatous Polyzoa. Cells moveable; no gizzard. Three species. (Hincks, *Polyz.* 542.)

TRI'TON, Laur. (water-newt).—A genus of Reptiles.

If a male and female *T. cristatus* (fig. 767),

Fig. 767.

one of the common water-newts, be kept in a glass jar with healthy water-plants, they will lay their eggs upon them. The larvæ are very beautiful microscopic objects for showing the circulation in the gills and tail, the chorda dorsalis and the embryonic tissues; they should be kept in a vessel separate from the parents; otherwise these will devour them.

The injected skin of *T. palustris*, the large water-newt, forms a beautiful opaque object, showing the loose capillary network, which

contrasts well with the brilliantly mottled skin.

Bibl. Bell, *British Reptiles*.

TROCHAM'MINA, Parker and Jones.—A variable genus of Arenaceous Foraminifera, very near *Lituola*; shell opaque, sandy, smooth; moniliform, serpentine, folded, discoidal, or subnautiloid and rotalioid; segmentation mostly obsolete except in the last. Very many species or varieties, recent and fossil. The discoidal forms constitute Reuss's *Ammodiscus*. *Tr. incerta*, Pl. 23. fig. 14.

Bibl. Parker and Jones, *Q. J. Geol. Soc.* xvi. 304; *Ann. N. H.* 4. iv. 386; Carpenter, *For.* 141.

TROCHIL'IA, Duj.—A genus of Hypotrichous Infusoria, family Ervilina.

Char. Body irregularly oval, narrower in front, where there are some cilia; carapace obliquely furrowed, slightly twisted, and terminated behind by a moveable pedicle.

T. sigmoides (Pl. 32. fig. 13); fig. 12 represents the animal undergoing transverse division; marine. Two other species.

TROMBIDI'NA.—A family of Acarina.

Char. Palpi with the last joint obtuse, the last but one unguiculate, the second very large; legs for walking, with two claws; eyes usually latero-anterior.

Principal genera: *Anystis, Cheyletus, Megamerus, Pachygnathus, Raphignathus, Rhyncholophus, Smaris, Tetranychus*, and *Trombidium*.

TROMBIDI'UM, Latr.—A genus of Trombidina (Arachnida).

Char. Palpi large, free; mandibles unguiculate; body turgid, bearing the four posterior legs, and an anterior narrow moveable prominence, upon which the eyes, the four anterior legs, and the mouth are situated; anterior legs longest; legs seven-jointed.

The species are numerous, and not well characterized.

T. phalangii (Pl. 6. fig. 37). Body subtriangular, angles obtuse; of a velvety appearance, from the presence of numerous plumose hairs; eyes two, placed upon auricular appendages.

An external parasite of *Phalangium* (the harvest-spider) and insects, at least in its early hexapodous stage.

T. elongatum. Crimson; eyes approximate. Found under stones.

T. cinereum (Pl. 6. fig. 40) (*Rhyncholophus ciner.*, Dug.). Body with brown and greyish-white spots; hairs spathulate; eyes two on each side. Length 1-12". Found in ditches amongst plants and stones.

T. autumnale (Pl. 6. fig. 38) (*Leptus autumn.*). The harvest-bug. This well-known arachnidan insinuates itself into the human skin in autumn, causing troublesome irritation. It is found on plants and the stubble of corn-fields, and may easily be caught by tying a white pocket-handkerchief around the legs, and walking through stubble-fields. The young form with six legs is most frequently met with.

T. aurantiacum, on the black bean-*Aphis*. Other species.

T. (*Atoma*) *parasiticum*, on the house-fly. Other species.

Bibl. Dugès, *Ann. Sc. N.* 2. i. 36; Gervais, *Walck. Aptères*, iii. 178; Johnston, *Tr. Berwick. Nat. Club*, 1847, 221; Koch, *Deutschl. Crust. Myriap. &c.*; Murray, *Ec. Ent.* 128.

TRUNCATULI'NA, D'Orb.—A subgenus of *Planorbulina*. Shell discoidal, plano-convex, thick or thin, lobular or neat, adherent by the flat face; orifice slit-like, slightly apparent above and continued beneath, along the line of suture, as far as the second or third chambers.

Many recent and fossil species. *Pl.* (*Tr.*) *lobatula* (Pl. 24. fig. 9); very common, attached to sea-weeds.

Bibl. Williamson, *Rec. For.* 50; Carpenter, *Foram.* 207; Parker & Jones, *Phil. Trans.* clv. 381.

TRYBLIONEL'LA, Smith.—A genus of Diatomaceæ.

Char. Frustules free, linear or elliptical in front view; valves plane, with parallel transverse (tubular?) striæ, and submarginal or obsolete alæ.

In some a median line is present, in others not. The alæ are not marginal, as in *Surirella*, but arise from the surface of the valves, as shown by the diagram of a transverse section in Pl. 17. fig. 32.

T. scutellum (Pl. 17. fig. 30). Valves elliptical, with a median longitudinal line: alæ very short; striæ faint; marine; length 1-140".

T. gracilis (Pl. 17. fig. 31). Frustules linear, narrowed at the ends; valves linear, acuminate, striæ coarse; alæ distinct; fresh and brackish water; length 1-200".

Four other species.

Bibl. Smith, *Brit. Diatom.* i. 35; Rabenh. *Alg.* i. 347.

TRYPANOSO'MA, Gruby.—A genus of Flagellate Infusoria. Free, compressed;

one side thin, undulating, frill-like; anteriorly produced into a long flagellate appendage; no mouth.

T. sanguinis, in frog's blood, length 1-600″; *T. Eberthi*, in the intestines of poultry. (Gruby, *Compt. Rend.* 1843; Kent, *Inf.* 218.)

TUBER, Mich. See TUBERACEI.

TUBERA'CEI.—A family of Ascomycetous Fungi, growing underground or upon the surface, of more or less round form, and solid, fleshy texture, excavated with sinuous cavities lined by *asci* containing usually four or eight spores, elegantly reticulated or spinulose (figs. 768–770). The internal

Fig. 768.

Fig. 769.

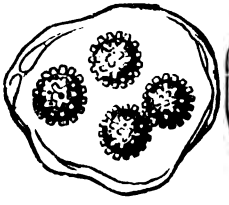
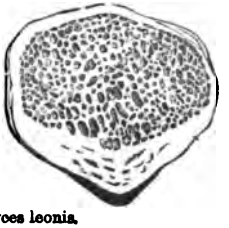


Fig. 770.



Choiromyces leonis.

Fig. 768. A peridium. Nat. size.
Fig. 769. An ascus with spores. Magnified 400 diameters.
Fig. 770. Vertical section of a peridium.

substance either dries and grows hard, or falls into a flocculent powder with age.

Tuber cibarium is the common truffle. Sections of the marbled internal substance show this to be composed of interlacing branched filaments, forming fleshy convolutions, between which serpentine cavities are alternately excavated; branches of the filaments free at the surface of the lacunæ bear spherical sacs (*asci*), each containing four globular spores of yellow-brown colour, having an elegantly reticulated outer coat. When the spores germinate, they produce a subterraneous cottony mycelium, which after a time presents villous nodules, in the interior of which the peridia are developed; as these advance, the villous coats gradually vanish, together with the mycelial structure, and the mature peridia appear free, either a little beneath (*Tuber cibarium*) or upon the surface (*T. album*) of the soil (see also ELAPHOMYCES).

BIBL. Berk. *Br. Fl.* ii. pt. 2. 227; Tulasne, *Ann. Sc. Nat.* 2. xvi. 5; *Monog. Fung. Hypogæi*, 1851; *Ann. N. H.* 2. viii. 19; Lespiault, *Ann. Sc. Nat.* 3. ii. 316; Vittadini, *Monog. Tuber.*; *Monog. Lycopod.*, *Mém. Turin Acad.* 2. v. 145.

TUBERCLE or TUBERCULAR MATTER.—Tubercle consists of lymphatic corpuscles contained in the meshes of a very delicate reticulum, or a transparent homogeneous tissue (Pl. 38. fig. 8). The cells vary in size, and many contain a small distinct nucleus. In addition to these, there are a few larger cells containing two or even three nuclei. The nucleated cells are exceedingly destructible, so that often more free nuclei than cells are visible. In most cases the tubercle appears to consist entirely of closely crowded nuclei or so-called tubercle-corpuscles (Pl. 38. fig. 9 *a*), about 1-5000 to 1-4000″ in size, oblong-angular, and unaffected or simply rendered paler by acetic acid (fig. 9 *b*).

Tubercle appears to originate most frequently from the tissue which surrounds the small arteries in every situation, constituting the lymphatic sheaths. The small cells in this situation multiply at separate centres, and thus miliary nodules are produced around the vessel; and as they gradually develope, they compress the vessel, and may finally occlude it. Tubercle invariably undergoes a retrogressive change; this commences in the centre of the granulations, and consists in the atrophy and incomplete fatty metamorphosis of the closely crowded cellular elements, constituting what is termed caseation. The translucent and grey granulations thus become opaque and yellowish, the yellow tubercle being merely a stage of the grey granulation. The caseous tubercle subsequently softens, or may gradually dry up into a firm cheesy mass, which becomes ultimately calcified.

BIBL. Green, *Path. Anat.* 1871, 145; Rindfleisch, *Path. Hist.* 1878.

TUBERCULA'RIA, Tode.—A supposed genus of Stilbacei (Hyphomycetous Fungi), but apparently only preparatory forms of Sphæriaceous Fungi. *T. vulgaris* is a state of *Nectria* (*Sphæria*) *cinnabarina*; it is ex-

tremely common in autumn and winter, on dead sticks, damp wooden palings, stumps, &c., forming scarlet-orange rounded nodules, or irregular fleshy masses, sometimes more or less stipitate, the surface at a certain stage exhibiting the ends of the filaments terminating in chains of cells breaking up into a pulverulent substance. These cells are probably the conidia of the *Nectriæ*.

TUBICLA'VA, Allman.—A genus of Athecate Hydroid Zoophytes.

Char. Stems erect, simple or branched, arising from a creeping stolon; polypes claviform, with scattered filiform tentacles. Reproduction by means of fixed sporosacs in clusters on the body of the polype, behind the posterior tentacle, or on very short stems developed on the creeping base.

BIBL. Hincks, *Hyd. Zooph.* 10; Allman, *Ann. N. H.* 3. xi. 9.

TUBICOLA'RIA, Ehr.—A genus of Rotatoria, fam. Floscularieæ.

Char. No eye-spot; disk four-lobed; stalk long, contained in a transparent gelatinous sheath. *T. najas*, jaws with four teeth; on *Lemna*. (Ehrenberg, *Infus.*; Pritchard, *Inf.*)

TU'BIFEX, Lamk.—A genus of Annulata, order Setigera.

Char. Body filiform, attenuated at the ends, pellucid, with four rows of setæ—two dorsal and two ventral.

The worms live and burrow in the mud of stagnant pools or the still parts of rivers, giving it a bright-red appearance. When the water or mud is disturbed, the red patches instantly disappear, from the retraction of the animals. Length from 1-5 to 3-4″ or more.

They are transparent, and show well the alimentary canal, with its peristaltic actions, and the cilia lining it, the blood-vessels and their movements, with the loops bathed in the chylaqueous liquid, and the coiled water- (respiratory or renal) vessels with their cilia.

BIBL. Schmidt, *Müller's Archiv*, 1846, 406; Dugès, *Ann. Sc. Nat.* 2. xv. 319; Johnston, *Ann. N. H.* 1845, xvi. 443; Lankester, *Qu. Mic. Jn.* 1871, 180.

TUBULA'RIA, Linn.—A genus of Hydroid Zoophytes, family Tubulariidæ.

BIBL. See TUBULARIIDÆ.

TUBULA'RIIDÆ.—A family of Athecate Hydroid Zoophytes.

Char. Polypes flask-shaped, with two sets of filiform tentacles, one oral, the other near the base.

Tubularia. Stem twisted, branched or unbranched; tentacles filiform in two rows; egg-germs or gonophores on short footstalks, clustered at the bases of the lower tentacles.

Corymorpha. Partly enclosed; polypidom short, thin, membranous, swollen at the base, which is immersed in the sand; polype single, head club-shaped, encircled at the base by long filiform tentacles, and a circle of short ones around the tip.

Ectopleura. With free medusiform sexual buds.

BIBL. Hincks, *Hyd. Zooph.* 114; Lister, *Phil. Tr.* 1834; Johnston, *Br. Zooph.* 48: Mummery, *Qu. Micr. Jn.* 1853, 28; Wright, *Ed. New Phil. Jn.* 1858, 113; Allman, *Ann. N. Hist.* July 1859, and July 1864; Van Beneden, *Tubulaires.*

TUBULIPO'RA, Lam.—A genus of Infundibulate Cyclostomatous Polyzoa, of the family Tubuliporidæ.

Three British species; some of them common upon shells, sea-weeds, &c.

Pl. 41. fig. 30 represents a species (not British).

BIBL. Johnston, *Br. Zooph.* 266; Hincks, *Polyz.* 442.

TUBULIPOR'IDÆ.—A family of Infundibulate Cyclostomatous Polyzoa.

Char. Polypidom calcareous, massive, circular, lobed or divided dichotomously; cells long, tubular, with a round, prominent, unconstricted orifice. Genera:

Tubulipora. Wart-like, with a defined base; cells suberect, aggregated or in imperfect rows, more or less free at the end.

Diastopora. Incrusting, undefined; cells alternate, tubular, horizontal, immersed, with a raised circular orifice.

Idmonea. Divided dichotomously, erect; cells on one side, tubular, in transverse rows, divided into two sets by a median longitudinal line.

Pustulipora. Erect, cylindrical; cells semi-immersed, on all sides, orifices prominent.

Alecto. Creeping, adherent, irregularly branched; cells horizontal, in one or more rows, their ends free.

BIBL. Johnston, *Br. Zooph.* 264; Gosse, *Mar. Zool.* ii. 7.

TUBURCIN'IA, Fries.—A genus of Ustilaginei (Hypodermous Fungi), occurring in vegetable tissues.

T. scabies produces the disease called scab in potatoes; *T. trientalis* occurs on leaves of *Trientalis Europæa*; conidia are produced on the underside of the leaves.

Bibl. Berk. & Br. *Ann. N. H.* 2. v. 464; Cooke, *Handb.* 516; De Bary & Woronin, *Beit.* v. pls. 1–3.

TUMOURS. — Non-inflammatory new formations. Under this head we shall make a few remarks upon some of the more interesting elements of certain tumours and other morbid growths.

Sarcoma. The tumours included under this name, comprise the fibro-plastic, fibro-nucleated, recurrent fibroid, and the myeloid. They consist of connective tissue, retaining more or less the embryonic type; and the varieties depend upon the size and form of the cells, and the nature of the intercellular substance. The cells are either round, fusiform, or myeloid—larger cells containing many nuclei or secondary cells. The intercellular substance is scanty, homogeneous, granular, or fibrillated.

Fibrous tumours consist of fully developed connective tissue. The fibres are sometimes firm and dense, at others lax. The cells or connective-tissue corpuscles are very few in number, and usually only become visible on the application of acetic acid. They are often minute spindle-shaped, fusiform, or stellate bodies, the latter having processes of varying length, which communicate with those from neighbouring cells.

Gummata are new formations, consisting of an incompletely organized granulation tissue. They soon undergo retrogressive changes; hence the growth is ultimately made up of atrophied, degenerated, and broken-down cell products, imbedded in an incompletely fibrillated tissue.

Myxomata consist of a translucent and succulent connective or mucous tissue, the intercellular substance of which yields mucine. They are of a peculiar soft gelatiniform consistence, and of a pale greyish or reddish-white colour. On scraping the cut surface they yield a tenacious mucilaginous liquid, in which may be seen the cellular elements. The cells are angular and stellate, with long anastomosing prolongations and trabeculæ; others are isolated, fusiform, oval, or spherical, with one or two nuclei.

Lipomata. Fatty tumours resemble adipose tissue, and consist of cells containing fat united by a variable quantity of connective tissue.

The *Enchondromata* and *Osteomata* consist of cartilage and bone respectively; and the *Lymphomata* are new formations consisting of lymphatic, or, as it is usually termed, adenoid tissue.

The *Papillomata*, such as warts, horny growths, polypi, originate from the skin and mucous membranes, of the tissues of which they may be called exaggerations. The *adenomata*, or tumours of glands, are new formations of gland tissue. They resemble the racemose glands, and consist of small grouped saccules or tubes filled with squamous or cylindrical epithelium-cells.

The *carcinomata*, or cancers, consist of cells of an epithelial type, without any intercellular substance, grouped together irregularly within the alveoli of a fibrous stroma. There are four varieties—scirrhus, encephaloid, epithelioma, and colloid. These, although all possessing the same general characters, present certain structural differences which serve to distinguish them. The cells are comparatively large, varying considerably in diameter, of a rounded, oblong, or ovate form, usually in no definite order, in the intervals of the fibres (Pl. 38. figs. 11 & 12), although sometimes in the meshes formed by the aggregation of the fibres into loose bundles (fig. 17).

The interspaces of the cells and fibres are occupied by a pale yellowish or colourless liquid; and the cells are so loosely imbedded in the fibrous basis, that on scraping the surface of a section of a cancer, numerous cells are found in the juice thus obtained.

The number of fibres present varies according to the stage or development of the cancer. In hard or schirrous cancer, they predominate, the cells being few; while in soft, encephaloid, or medullary cancer they are scanty, the cells being very abundant; globules of fat usually abound in the latter forms.

Other varieties of cancer have received special names. Thus, when the capillaries are very numerous and distended, extravasated blood being also frequently present, we have fungus hæmatodes; when the fibres are grouped into bundles, forming marked areolæ, filled with a gelatinous substance, we have colloid or gelatiniform cancer (Pl. 38. fig. 18); again, when the cancer cells abound in pigment, we have melanotic cancers.

In epithelial cancer, or *epithelioma*, the general arrangement of the elements is not strikingly altered, but the papillæ of the skin are hypertrophied, the epithelial cells more numerous than natural, sometimes containing many nuclei or secondary cells, and the intercellular juice is more abundant.

The flattened epithelial cells are also often arranged around the papillæ in the form of concentric rings or nests, resembling fibres; but the cell-structure is at once rendered evident by the addition of solution of potash.

In regard to cells generally, an insuperable difficulty is met with in discovering the exponent of their power, as it might be termed; thus the embryonic cells or corpuscles in an early stage are undistinguishable from each other, yet some grow into fibres of connective tissue, others into nerve-tubes, &c. Chemistry lends no aid here, and the difficulty will probably ever remain.

In the examination of tumours and other morbid growths, sections should be made with a Valentin's knife, the elements being first observed in water, and then in the natural fluid. The sections and elements are best preserved in water.

Bibl. Paget, *Tumours* and *Surgical Pathology*; Bennett, *on Cancer*, and *Ed. Mn. Jn.* vii. & viii.; Redfern, *ibid.* xi.; and the *Tr. Pathol. Soc.*, passim; Green, *Path. Anatomy*; Rindfleisch, *Path. Gewebel.*

TUNICA'TA.—A class of Animals, belonging to the Invertebrate subkingdom Mollusca.

Char. Marine; often microscopic; bodies single, social, or aggregate; acephalous; enclosed in an elastic tunic with two orifices, one oral and branchial, the other anal or cloacal; a large atrial system, the pharynx communicating with it by branchial slits; respiration branchial, branchiæ pharyngeal; nervous system a ganglion; circulation effected by a tubular heart, with vessels, the current of blood varying in direction; hermaphrodite; evolution accompanied by metamorphosis, or following the law of alternation of generations (Pl. 18. figs. 10 & 20).

The smaller Tunicata are commonly found aggregate, and investing rocks, stones, and shells; some are adherent to seaweeds, &c., a few are free; many are common on the sea-shore.

The body is sac-shaped or elongate, sometimes slightly constricted so as to exhibit a thorax, abdomen, and a posterior portion or postabdomen. The outer coat, test or tunic, is cartilaginous, leathery, gelatinous, or membranous; and consists partly of cellulose, often containing calcareous spicula. Within this is another coat, the mantle, usually adhering to the former at the orifices only, and containing numerous muscular fibres. The oral orifice (Pl. 18. fig. 10, *a*), or opening of the usually dilated pharynx or branchial cavity, within which is placed the branchial apparatus (*b*), leads to the mouth. This is slit-like, and leads into a narrow œsophagus; to this succeeds an expanded stomach (*l*), which terminates in a longish intestine with a hæmal curve (*i*), and ends at the base of the cloaca (*i**), which opens externally at the atrial orifice. Within the oral orifice, at the commencement of the branchial cavity, is a ring of rudimentary tentacles.

The branchial apparatus in the pharynx (fig. 10, *b*) consists of numerous cross bars, with slit-like openings between them; these are ciliated, and copiously supplied with networks of blood-vessels. The slits open into the atrial system. The current excited by the cilia draws the water through the oral orifice into the pharynx, where it traverses the openings, flowing outwards to collect in the cloaca, from which it is expelled through the atrial orifice. In some of the larger Tunicata, the branchial apparatus is strap-shaped, and traverses the body obliquely.

The heart (*h*) is a spindle-shaped sac, enclosed in a pericardium (*p*), and situated near the base of the body, the principal vessels running on the dorsal and ventral surface of the branchial apparatus. The current of blood varies in direction, being at one time expelled from one end of the heart, at others from the other. In those Tunicata which are connected by a common tube, the blood passes freely from one to the other.

The nervous system consists of a single ganglion (fig. 10, *g*), situated between the two orifices, and giving off its principal branches to the branchial sac and the alimentary canal. In some an eye is present, resembling the compound eye of the Articulata, and with a reddish pigment.

Moreover an auditory capsule has been noticed in some genera.

The liver (*l*) consists either of a dark glandular layer lining the alimentary canal, or of distinct glandular cæca.

The Tunicata are reproduced by gemmation, by sexual organs, and by intermediate generations.

The testis (*t*) and ovary (*o*) are usually strap-shaped organs, either adherent to the alimentary canal, or situated in the posterior part of the body; the former has a long

spermatic duct (*d*), which opens into the cloaca, into which also the ova or larvæ are discharged, to escape by the posterior orifice. The larvæ often resemble at first tadpoles with three anterior sucker-like organs, by means of which they adhere to foreign bodies to complete their development, the tail gradually disappearing. In *Appendicularia* the larval form persists through life.

The larval caudal appendage has been shown to have a rod-like body, which has been compared to the chorda dorsalis of Vertebrata.

In the large free Tunicata, the intermediate generations are united into long chains, the final product being a sexual individual; but into the further structure of these curious beings we have no space to enter.

Synopsis of the Families.

* *Attached; mantle and test united only at the orifices.*

BOTRYLLIDÆ. Bodies united into systems.

CLAVELINIDÆ. Bodies distinct, but connected by a common root-thread.

ASCIDIADÆ. Bodies unconnected.

** *Free; mantle and test united throughout.*

PELONÆADÆ. Orifices near together.

SALPIDÆ. Orifices at opposite ends.

BIBL. M.-Edwards, *Ascid. Comp.*, and *Mém. de l'Institut*, 1842; Forbes and Hanley, *Br. Moll.* i. 1; Siebold, *Vergl. An.* 234; Lister, *Phil. Tr.* 1834; Huxley, *Comp. An.*; Rupert Jones, *Todd's Cyclop.*, Art. *Tunicata*; Allman, *Qu. Mic. Jn.* vii. 86; Gegenbaur, *Vergl. An.*; Nicholson, *Zool.* 363.

See APPENDICULARIA, BOTRYLLIDÆ, CLAVELINIDÆ, &c.

TURBELLA'RIA.—An order of Annulata.

TURBINEL'LA, Schultze.—A genus of Ichthydine Rotatoria.

BIBL. Schultze, *Müller's Archiv*, 1853, 241; Pritchard, *Inf.* 381.

TURMERIC. See CURCUMA.

TUR'RIS, Lesson.—A genus of Athecate Hydroida, family Clavidæ.

Char. Stems short, rooted, bearing the polypes on their summits; polypes claviform, with scattered filiform tentacles. *T. neglecta*, in the Solent, Ilfracombe, &c. (Hincks, *Hyd. Zooph.* 13.)

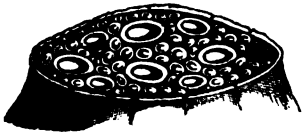
TYDÆUS, Koch.—A genus of Trombidina (Acarina). Transverse line present; no eyes; legs six-jointed. *T. mutabilis*, very minute, on damp earth or moss. (Koch, *Uebers.*; Murray, *Ec. Ent.* 120.)

TY'PHOID CELLS.—In typhoid fever certain special uninuclear cells are formed, which contain more protoplasm and are larger than lymph-cells, pus-corpuscles, and white blood-corpuscles; these assume an irregular and often polygonal form. Degenerative changes speedily commence, and the cells break up, mostly by fatty metamorphosis, into oily débris capable of reabsorption. The cells are found not only in the intestinal structures, but also in other organs; forming medullary masses on the pleural surface, and inside the sarcolemma of muscles.

BIBL. Rindfleisch, *Path. Gewеb.* 317.

TYM'PANIS, Fr.—A genus of Phacidiacei (Ascomycetous Fungi), consisting of horny bodies growing on branches of trees, breaking out through the bark. *T. conspersa* (fig. 771) grows upon Rosaceous

Fig. 771.



Tympanis conspersa.

A collection of perithecia, more or less mature, bursting through the bark. Magn. 10 diams.

trees, *T. saligna* on the privet. In the former the perithecia are collected in tufts; they are first closed, afterwards opening into cups, the disk of which is occupied by the hymenium, bearing long and broad asci containing numerous spores, and sometimes also septate stylospores simultaneously. In *T. saligna* the perithecia occur only two to four together. *Spermogonia* exist (which are oblong or conical bodies) intermixed with the perithecia, perforated by a terminal pore (resembling perithecia of *Sphæria*); these are lined with delicate branched filaments bearing minute corpuscles (*spermatia*), which

Fig. 772.

Vertical section through a piece of the above, passing through some of the open cup-like perithecia.

Magnified 20 diameters.

when mature escape from the pore in a tendril (as in *Cytispora*) if moistened or pressed (see also CENANGIUM).

BIBL. Berk. *Br. Fl.* ii. pt. 2. 210; *Ann. N. H.* 2. vii. 185; *Hook. Jn. Bot.* iii. 322; Tulasne, *Ann. Sc. Nat.* 3. xx. 143, pl. 16. figs. 15, 16; Fries, *Sum. Veg.* 399; Greville, *Crypt. Fl.* pl. 335.

TYPH'LINA, Ehr.—An imperfectly examined genus of Rotatoria, of the family Philodinæa. *T. viridis* (Pl. 44. fig. 33). Found in Egypt. (Ehrenberg, *Inf.* 483.)

TYROG'LYPHUS. See ACARUS.

TYRO'SINE.—This substance is generally found associated with leucine. It forms silky-white needles, often in stellate groups, difficultly soluble in water, and entirely insoluble in alcohol and ether. When warmed with sulphuric acid, and perchloride of iron is added, it is rendered violet. The little white grains found upon anatomical preparations preserved in spirit consist of tyrosine. (Hoppe-Seyler, *Analyse Chim.*; Frey, *Hist.* 51.)

U.

U'LOTHRIX.—A genus of Confervaceæ (Confervoid Algæ), allied to *Draparnaldia* and *Stigeoclonium*. They consist of unbranched filaments, adhering loosely together to form a mucous stratum, growing upon stones &c. in fresh water. The filaments are composed of short hyaline cells (Pl. 9. fig. 6), the green contents of which are at first granular, adhering to the walls (*a*), then contracted into transverse bands (*b*). Contractile vesicles have been observed in the cells of some species. According to recent observations, macrospores with four cilia occur singly or in twos, in certain cells; while in others, numerous biciliated microspores are formed, which conjugate and produce resting spores; these again give rise to zoospores, from which new filaments arise.

U. zonata. Filaments 1-960″ in diameter, joints about as long (*Lyngbya zon.*, Hass. pl. 59. figs. 2, 3, & 6).

U. pectinalis. Filaments 1-1800″ to 1-960″ in diameter, joints half or a fourth the length; fertile cells swollen (Hass. pl. 60. figs. 1–5).

U. crispa. Filaments very long, 1-600″ in diameter, joints half or a third as long (*Conferva bicolor, Eng. Bot.* p. 2288).

U. floccosa. Filaments 1-2100″ to 1800″ in diameter, joints about as long (*Lyngbya floccosa*, Hass. pl. 60. figs. 1 & 2).

U. punctalis. Filaments 1-3000″ to 1-2500″ in diameter, regularly torulose; joints two and a half times as long as broad (*Lyngb. punct.*, Hass. pl. 60. fig. 4; including perhaps *L. virescens* and *L. vermicularis*).

U. speciosa. Filaments 1-780″ to 1-420″ in diameter, curled; sterile joints half or a third as long.

U. mucosa, Thuret (Pl. 9. fig. 6). Pale green or yellowish, slimy; joints usually as long as broad, sometimes shorter, 1-3000″ in diameter.

BIBL. Kützing, *Sp. Alg.* 345; *Tab. Phyc.* ii.; Hassall, *Alg.* 219; Thuret, *Ann. Sc. N.* 3. xiv. 222, pl. 18; Rabenht. *Alg.* iii. 365; Cramer, *Bot. Zeit.* 1871; Dodel, *Pringsheim's Jahrb.* x. 417.

UL'VA, Linn.—A genus of Ulvaceæ (Confervoid Algæ), here taken in the sense of Thuret. The plants are all marine, consisting of broad, green, simple, or lobed, membranous fronds, growing upon rocks and stones. The cells are rounded-angular (Pl. 9. figs. 2 & 3), and are at first filled with amorphous green colouring-matter, which subsequently becomes collected into masses (*a*), ultimately converted into numerous zoospores. Under the influence of light, those soon "swarm" and break out from the cells by a pore in the outer wall (fig. 3 *b*). The emptied cells give a pale colour to the parts of the frond where they are situated. The zoospores appear in two forms, some large and bearing four cilia (fig. 3 *c*), others much smaller and possessed of only two cilia (fig. 2 *b*). The fronds in which the latter occur are generally of a yellower colour. Thuret has seen both kinds germinate. As defined by that author, the British species stand as follows:—

U. Lactuca, L. Frond broadly ovate or oblong, 6 to 18″ long, and several inches wide.

β. latissima. Frond 3′ or more long, 18″ or more wide; found in the muddy water at the entrance of harbours (*Phycoseris Myriotrema*, Kütz. *Sp. Alg.*) = *U. orbiculata.*

U. Linza, L. Frond linear-lanceolate, 6 to 24″ long, ½ to 1½″ wide.

BIBL. Harvey, *Mar. Alg.* 216, pl. 25 B; Thuret, *Mém. Soc. Cherbourg*, ii.; *Ann. Sc. Nat.* 3. xiv. 224, pl. 20; Greville, Harvey, Kützing, *Algæ*; Rabenht. *Fl. Eur. Alg.* i. 316.

ULVA'CEÆ.—A family of Confervoid Algæ. Marine or freshwater Algæ, consisting of membranous, expanded, saccate

or tubular, sometimes filiform fronds, composed of spherical or polygonal cells, united together firmly into layers, either single or double. Reproduced by roundish spores formed from the whole contents of cells, or by ciliated zoospores formed in twos, fours, or many in each cell.

Ulva. Frond plane, simple or lobed, formed of a double layer of closely packed cells, producing zoospores.

Enteromorpha. Frond hollow, simple or branched, of a single layer of closely packed cells, forming a sac or tube; with zoospores.

Monostroma. Frond flat or saccate, simple or lacerate-lobed, forming a single layer of cells scattered in a homogeneous membrane; with zoospores.

Prasiola. Fronds membranous, lacerate-lobed, formed of a single layer of cells in simple or compound lines, or in groups multiples of four. Spores formed from the whole contents of the cells, motionless.

Schizogonium. Fronds filiform, dilated here and there into flat ribands, containing two or four rows of cells; spores formed from the whole contents, motionless.

See PROTODERMA and SCHIZOMERIS.

ULVI'NA. See CRYPTOCOCCACEÆ.

UMBILICA'RIA, Fée (*Gyrophora*, Ach.). —A genus of Phyllodei (Lichenaceous Lichens). *U. pustulata* grows on rocks in various parts of Britain. It is remarkable for the tubercles or hollow papillæ occurring on its surface. The apothecia are flat, at first black, at length tuberculate. Spermogonia also occur, in the form of little tubercles containing a nucleus of densely packed sterigmata, enclosed by a thin black rind. The species in which the disk of the apothecia is concentrically plicate form the proper *Gyrophoræ* of Ach.; they occur on mountain-rocks. Several other species.

BIBL. Hook. *Br. Fl.* ii. pt. 1. 223; Tulasne, *Ann. Sc. Nat.* 3. xvii. 207, pl. 5. figs. 5–12; Schærer, *Enum. crit.* 25; Leighton, *Lich. Fl.* 142.

UMBONEL'LA = LEPRALIA pt. (Hincks, *Polyzoa*, 316).

UNILOCULI'NA, D'Orbigny.—A subgenus of *Miliola.*

Char. Shell regular, equilateral, globular; *chambers* completely embracing, regularly wound round the axis, one only apparent, this making a complete revolution around the preceding; cavity simple; *orifice* single, with a tooth.

In the other genera of the family, each chamber occupies only half the circumference, whilst here it forms a complete circle. One species, *U. Indica* (Pl. 23. fig. 2). (D'Orb. *For. Fos. Vien.* 261.)

URATES. See URIC ACID.

URCEOLA'RIA, Ach.—A genus of Parmeliaceæ (Gymnocarpous Lichens), included under *Parmelia* by Fries, but agreeing in almost every particular with LECANORA. *U. scruposa*, the commonest species, grows on heaths, walls, and rocks. The disk of the apothecia is black, and the border crenated. The spores are cellular or multilocular (Pl. 37. fig. 17). The spermogonia are scattered over the thallus, sometimes in the outer wall of the (thallodal) border of the apothecia; they are very inconspicuous, on account of the light colour of their ostiole.

BIBL. Hook. *Br. Fl.* ii. pt. 1. 175; Tulasne, *Ann. Sc. Nat.* 3. xvii. 172, pl. 4. figs. 5–14; Schærer, *Enum. crit.* 85.

URCEOLARIA, Duj. = *Trichodina* pt. *U. mitra* = *T. mitra.*

URE'A.—This substance occurs normally in the urine of man and the carnivora, in small quantity in that of the herbivora; also in the amniotic liquid, and the vitreous and aqueous humours of the eye. Pathologically, it is found in the blood, dropsical effusions, vomited liquids, and doubtfully in the saliva, the bile, and perspiration.

When pure, it forms colourless four-sided prisms, sometimes longitudinally striated, and with one or two oblique terminal facets. The crystals are readily soluble in water and alcohol, but not in pure ether.

When nitric or oxalic acid is added to a solution of urea, the nitrate or oxalate separates in the crystalline form.

The nitrate of urea, when rapidly formed, consists of irregularly aggregated scaly crystals (Pl. 13. fig. 18 *c*); when more slowly formed, rhombic or hexagonal plates, or distinct prisms (fig. 18 *a*, *b*). The crystals of the nitrate of soda (Pl. 10. fig. 19) bear some resemblance to those of the urea salt.

The crystals of the oxalate of urea somewhat resemble those of the nitrate, the rhombic form being evident.

BIBL. That of CHEMISTRY, *Animal.*

UREDINE'ÆE. — The genus *Uredo* is shown by Tulasne to have no satisfactory claim to a distinct existence, since the structures which have represented it appear to be merely a form of the reproductive organs common to a number of plants, which, in their most perfect state, represent the genera *Puccinia*, *Phragmidium*, *Uromyces*, &c.

These constitute the genera of the family Uredinei.

Of the genus *Phragmidium*, *P. bulbosum* (*Puccinia rubi*, Schær.) is a species commonly occurring on the leaves of brambles, forming reddish, then orange, and finally blackish rusty spots (fig. 773). The first signs of reproductive organs appear in the middle of the spots on the upper face of the leaf, consisting of a few minute unilocular cavities (*spermogonia*) excavated in the leaf, with a little flat ostiole; in these occur ovate *spermatia* (see ÆCIDIUM), which are accompanied by a yellowish mucous liquid, and are expelled with this in the form of drops. Subsequently to this, the *Uredo*-fruits are developed, mostly on the lower face of the leaf, at the back of the spermogonia, or more rarely on the upper face, in a circle around them. They are pulverulent patches (fig. 773), solitary or a few together; and a vertical section (fig. 774) shows them to consist of paraphyses (fig. 775), and simple or branched short filaments bearing globose *stylospores* (fig. 776), which soon become detached, and in ripening acquire an echinate outer coat with numerous pores.

Fig. 773.

Leaf of bramble, with "Uredo ruborum." Half the nat. size.

Fig. 774.

Vertical section of the same Uredo-fruit, with paraphyses and imperfect stylospores. Magn. 460 diams.

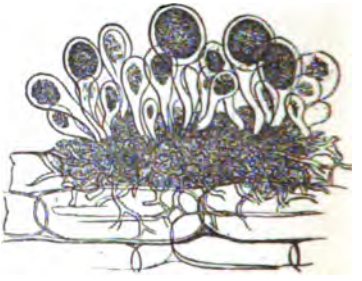
When these germinate, they produce merely a long slightly branched filament. Finally the perfect fruits (*spores*) appear on the same, or in distinct sori (on the lower face of the leaf) in the form represented in fig.

Fig. 775.

Fig. 776.

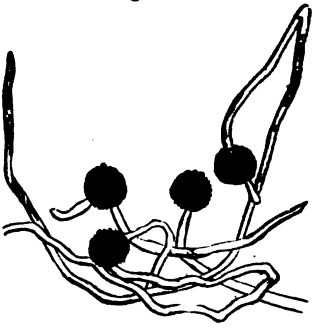
Fig. 775. Separate paraphyses.
Fig. 776. Detached pedicels with stylospores.
Magnified 460 diameters.

Fig. 777.



Vertical section of the sorus of "Uredo suaveolens," with immature stylospores. Magnified 460 diameters.

Fig. 778.



Ripe stylospores of the same, germinating.
Magnified 460 diameters.

Fig. 779.

Fig. 780.

Deformed stylospores, with the spinulose coat developed. Magnified 460 diameters.

565 (p. 594). The loculi of these have each three or four pores in the upper part of the side-walls, whence emerge in germination (in spring) short tubular filaments, which soon divide into four cells, from each of which arises a minute "sporidium" borne on a pointed sterigmatous process.

Puccinia compositarum exhibits very similar phenomena; its *Uredo*-fruit has been described as *Uredo suaveolens*. Fig. 777 represents a vertical section through an immature sorus of this; fig. 778 some of the *stylospores* detached and germinating; the outer spinulose coat is here fully developed, and the tubular filaments are seen emerging from the pores. The spores of the perfect fruits of this genus differ from those of *Phragmidium* in being bilocular, or, by abortion, unilocular (see PUCCINIA).

In ÆCIDIUM, CYSTOPUS, and some other genera, *spermogonia* and *stylosporous* fruits (*Uredo-fruits*, Tulasne) have been observed. In *Cronartium*, *spermogonia* are unknown, but the *Uredo*-fruit exists. In *Podisoma* both *spermogonia* and *Uredo*-fruits are unknown; in both of these genera the *perfect* fruits are placed on a fleshy *columella* or *ligula*.

We subjoin Tulasne's synopsis of the family; but as his generic characters are too long to transcribe, the typical species only can be cited.

I. *Albuginei*, white or pale yellow, heterosporous.
  Cystopus. Type, *Uredo candida*.
II. *Ædicinei*, with a peridium, homœosporous.
  Cæoma. Type, *Uredo euonymi*; *U. pinguis*.
  Ædicium. Type, *Æc. cichoracearum*; *Æ. tussilaginis*, *Æ. violarum*.
  Rœstelia. Type, *Æ. cancellatum*.
  Peridermium. Type, *Per. pini*.
III. *Melampsorei*, solid, pulvinate, biform.
  Melampsora. Type, *Uredo populina*; *U. caprearum*.
  Coleosporium. Type, *Uredo rhinanthacearum*; *U. campanulæ*.
IV. *Phragmidiacei*, pulverulent, biform, infuscate; centre of the family.
  Phragmidium. Types, *Phragmidium incrassatum*, with *Uredo ruborum*; *Puccinia potentillæ*, with *Uredo potentillarum*.
  Triphragmium. Type, *T. ulmariæ*.
  Puccinia. Type, *Puccinia compositarum*, with *Ur. suaveolens*; *P. graminis*, with *Ur. linearis*.
  Uromyces. Type, *Uredo ficariæ*.
  Pileolaria = *Uromyces*?, which itself may consist of species of *Puccinia* with spores unilocular by abortion.
V. *Puccinici*, fleshy, ligulate, or tremelliform, naked and uniform in the fruits; the largest plants of the family.
  Podisoma. Type, *P. juniperi communis*.
  Gymnosporangium. Type, *P. juniperinum*.
VI. *Cronartiei*, peridiate, biform, ligulate; perhaps the most highly organized of all the genera.
  Cronartium. Type, *Cr. asclepiadeum*, with *Uredo vincetoxici*; *C. pæoniæ*, with *Ur. pæoniæ*.

Genera cancelled by Tulasne:—*Uredo*, *Epitea*, *Podocystis*, *Trichobasis*, *Lecythea*, *Physonema*, *Solenodonta*.

Genera referred to USTILAGINEI:—*Ustilago*, *Tilletia*, *Thecaphora*.

Doubtful USTILAGINEI:—*Protomyces*, *Polycystis*, *Testicularia*.

BIBL. Berk. *Br. Fl.* ii. pt. 2. arts. *Æcid.*, *Puco.*, *Uredo*, *&c.*; *Ann. N. H.* i. 264, 2. v. 463; Tulasne, *Ann. Sc. Nat.* 3. vii. 12, 4. ii. 77; Léveillé, *ib.* 3. viii. 369; De Bary, *Brandpilze*, 1853; Fries, *Sum. Veg.* 509; Unger, *Exanth. Plant.*; and the BIBL. of the Genera.

URIC ACID and URATES, or lithic acid and lithates.—Uric acid may easily be procured in small quantities from human urine, by adding a few drops of dilute muriatic acid, and setting the liquid aside for some hours, when it subsides in crystals. In larger quantity it may be obtained by heating the excrement of serpents with excess of dilute solution of potash, until the odour of ammonia has disappeared, and filtering the solution whilst hot into dilute muriatic acid, when it falls in a colourless state. Or the excrement may be digested, without heat, with excess of strong sulphuric acid, the mixture set aside that the impurities may subside, and subsequently poured gradually into a large quantity of distilled water.

It exists also in the excrement of birds, in the urine of Mollusca and Insecta, and of all the Mammalia, excepting those which are herbivorous; it has also been found in the human blood, of which it is probably a normal constituent in minute quantity, although mostly secreted with the urine as soon as formed.

In the natural state of solution in the urine, uric acid exists combined with soda and ammonia; but it is frequently found as an abnormal deposit in the human urine, and is often precipitated after the secretion has been evacuated, from the occurrence of an acid fermentation. The crystals of the free acid are sometimes also met with in the urine or excrement of the lower animals, as Insects, &c.

Uric acid is but little affected by water, alcohol, acetic or muriatic acid, slowly soluble in solution of ammonia, but readily in solution of potash, from which it is re-precipitated by a dilute acid.

The crystals belong to the right-rhombic prismatic system.

Their various forms are represented in Pl. 12. figs. 1–10, and fig. 15. Those in fig. 1 are frequently met with as natural deposits from human urine, although most of the same forms, with those in fig. 15, are also found in the artificially precipitated acid. The most common and characteristic form is the rhomb (*a*), the side view being linear or rectangular. When the urine is strongly acid, the crystals often appear striated from the presence of linear fissures (*c, d*). Sometimes they are narrower and more elongate, with a prismatic form (*e*). They are frequently aggregated, and either fused into twin crystals (*f, g*), or form aigrettes or tufts (*k, l, m, n, o*). The other forms are noticed in the description of the plate.

The crystals forming a natural deposit are almost invariably coloured, from combining with the colouring-matter of the urine; sometimes their colour is very brilliant (fig. 4); they may also be coloured artificially by precipitation from a solution of purpurate of ammonia (fig. 3), madder, &c.

The test for uric acid is the production of the colour of purpurate of ammonia or murexide, which may be effected by dissolving the crystals or suspected substance in a small quantity of dilute nitric acid, gently evaporating the solution to dryness, and adding a little ammonia to the residue, or exposing it to the vapour of ammonia, when the red colour becomes visible. But the rhombic form, when present, with the action of potash and dilute acid, would be sufficient to distinguish this acid from most substances.

The formation of the crystals of uric acid presents an interesting object for examination. A drop or two of solution of uric acid in potash is first placed upon a slide and covered with thin glass; a little dilute muriatic acid is then applied to the edge of the liquid, or a drop of strong acetic acid placed near its edge, so that the vapour may be absorbed by the liquid. The latter soon becomes turbid, from the formation of a precipitate of numerous molecules and granules. If the turbid liquid be watched under the microscope, a minute crystal will presently be seen to form suddenly in some part of the field. The molecules and granules then slowly dissolve immediately around the crystal, leaving this in the middle of a clear space. The crystal now enlarges, and the surrounding molecules gradually disappear, until they at last entirely vanish from the field. By careful inspection, it may easily be seen that the crystal is not formed by the coalescence of the precipitated molecules, but is deposited from a state of solution.

Some crystals of uric acid polarize light splendidly; and some of the feathery crystals (Pl. 12. fig. 8 *e*) possess considerable analytic power.

The forms of the crystals and crystalline groups of the urates are represented in Pl. 12. figs. 11–14; they are not very characteristic, and the aid of chemistry is required for determining with certainty the composition of the respective crystals.

The urate of ammonia may be prepared artificially by adding ammonia to a boiling mixture of uric acid and water; the urate of lime by mixing urate of potash with chloride of calcium; the urate of soda by dissolving uric acid in solution of soda; and the urate of magnesia by mixing solutions of sulphate of magnesia and urate of potash.

The presence of an excess of uric acid in the blood is the chemical expression of gout; it leads to an abnormal precipitation of urates in various parts of the body. In cartilage the cells are the chief depositories of the urates of soda and lime, and they form the centres of the stellate bundles of crystals by which the tissue is permeated. The appearance of cartilage thus affected is very characteristic; and each cartilage cell is surrounded by radiating tufts of crystals which nearly or quite touch the extremities of other groups radiating from neighbouring cells. See URINARY DEPOSITS.

BIBL. Rindfleisch, *Path. Hist.* ii. 270; and that of CHEMISTRY, *Animal.*

URINARY DEPOSITS.—We shall give here a list of the deposits most commonly occurring in the human urine, with the references to the plates in which they are

represented, and the articles in which they are described.

Since the publication of the important paper by Vigla (*L'Expérience*, 1839), in which most of these deposits were first illustrated, the use of the microscope has constantly been called in to aid in their detection. In regard to the pathological indications afforded by their presence, upon which we cannot enter, it may be remarked that most of the deposits are formed after the evacuation of the urine.

Uric acid. Pl. 12. figs. 1, 2; and *Urates*, figs. 11 *c*, *d*, *e*, 13 *a*, 14 *a* (URIC ACID and URATES).

Oxalate of lime. Pl. 13. figs. 9, 10, 11, 12 (LIME, Salts of). The concretionary forms of this salt (figs. 11, 12) are more slowly acted upon by reagents than simple crystals.

Ammonio-phosphate of magnesia. Pl. 13. figs. 1, 2, 3, 4 (MAGNESIA, Salts of).

Carbonate of lime. Pl. 13. fig. 8 (LIME, Salts of).

Cystic oxide. Pl. 13. fig. 5 (CYSTIC OXIDE).

Blood-corpuscles. Pl. 49. fig. 21, especially the form fig. 21 *e* (BLOOD).

Mucous corpuscles. Pl. 1. fig. 5 (MOUTH, p. 518).

Pus-corpuscles. Pl. 38. figs. 4, 5 (PUS).

Spermatozoa. Pl. 50. fig. 25 (SPERMATOZOA). These are found in the urine of the female for several days after intercourse; and we have detected them in the uterus more than a fortnight after the same.

Sarcina? Pl. 7. fig. 5 (SARCINA).

Fungi. Penicillium (fig. 557, page 584; Pl. 26. fig. 15) and *Torula* (Pl. 26. fig. 7). The spores of *Penicillium* form the so-called small organic globules.

Casts of the tubuli uriniferi. The extreme diameter of these is rather less than that of the tubules; but they are often much more slender. They are cylindrical, generally wavy, sometimes hollow, at others solid. Some are very transparent, finely granular, and are composed of fibrine; others consist entirely of, or contain imbedded in them, renal epithelial cells, with or without globules of fat either free or within the cells; they sometimes also contain mucous and pus-corpuscles, with blood-globules; some of the epithelial cells occasionally contain lithates. The epithelium of the bladder agrees essentially in structure with that of the pelvis of the kidney.

BIBL. That of CHEMISTRY, *Animal*; Hoppe-Seyler, *Chim. phys. &c.*; Schmidt, *Versuch. &c.*; Griffith, *Urinary Deposits* and *Med. Gaz.* 1843.

URNATEL'LA, Leidy.—A genus of freshwater Polyzoa.

Not yet found in Britain.

BIBL. Leidy, *Pr. Ac. Philadelphia*, v. & vii.; and Allman, *Polyzoa*, 117.

UR'NULA, Clap. et Lach.—A genus of Actinophryina (Rhizopoda).

Char. Sheath membranous and fixed to other bodies. *U. Epistylidis* (Pl. 52. fig. 15), attached to the pedicle of *Epistylis plicatilis*. (Clap. et Lach. *Inf.* 457.)

UROCENTRI'NA. A family of Ciliate Infusoria.

BIBL. Clap. et Lach. *Inf.* 134.

UROCEN'TRUM, Nitzsch.—A genus of Peritrichous Infusoria, family Urocentrina.

Char. Free, no pedicle; tail awl-shaped; cilia absent from the body, but forming an anterior crown; mouth not spiral.

U. turbo (Pl. 32. fig. 14). Body hyaline, ovate, trilateral, tail one third the length of the body. Freshwater; length 1-430 to 1-290". (Cl. & Lachm. *Inf.* 134; Kent, *Inf.* 641.)

UROCOC'CUS, Hassall.—A genus of Palmellaceæ (Confervoid Algæ), remarkable for the peduncular processes formed by the gelatinous coats of the cells. The cells are invested by a gelatinous coat or membrane (like that of GLŒOCAPSA), which is originally simple; but new gelatinous layers are successively produced on the immediate surface of the cell-contents; and as each new one is formed the preceding layer is ruptured on one side and partially thrown off, the cell with its new layer lying in the preceding layer as in a cup; by the repetition of this process the cup-like exuviæ accumulate, packed one within another so as to form a peduncle, the structure of which may be roughly compared to a pile of wooden washing-bowls or tea-cups standing one in another. When the cell-contents divide into two portions, the peduncles bifurcate (Pl. 7. fig. 7). The striæ indicating the successively shed coats are more or less distinct in different species, and probably in different conditions of the same. *U. Hookerianus* is represented in Pl. 7. fig. 7; *U. insignis* is very much larger; *U. Allmanni* and *U. cryptophila* are much alike, and neither presents the striæ. A green species is also described with the synonym (erroneous?) of *Chlorococcum murale*, Grev. Reproduction unknown.

Bibl. Hassall, *Mar. Alg.* 322, pl. 80; Braun, *Verjüngung* (*Ray Soc.* 1853, 178); Rabenht. *Alg.* iii. 31.

UROCYS'TIS. See Polycystis.

UROGLAUCINE. — This substance, which was first detected by Heller, may be obtained by evaporating human urine with concentrated nitric acid (Pl. 13. fig. 20). Its true nature is unknown; but it is probably a product of the decomposition of the colouring-matter of the urine; it has perhaps some relation with indigo.

Bibl. Heller, *Archiv phys. Chemie und Mikr.*; Lehmann, *Phys. Chem.*; Funke, *Atlas.*

UROGLE'NA, Ehr.—A supposed genus of Volvocineæ (Confervoid Algæ), consisting of a family of zoospore-like individuals arranged at the periphery of a membranous sphere, as in *Volvox*, but said to differ from that genus in having only one cilium, and a basal prolongation or tail running toward the centre of the sphere. *U. volvox* forms a sphere, 1-95″ in diameter, with yellowish bodies 1-1728″ long, two lateral colour-bands, exclusive of the tail, which is three or four times as long. Inhabiting bog-pools. Kent places it among the Flagellate Infusoria. (Ehr. *Inf.* 61; Kent, *Inf.* 414.)

UROLEP'TUS, Ehr.—A genus of Hypotrichous Infusoria, family Colpodina; freshwater.

Char. Eye-spot absent; no tongue-like process or proboscis; a tail present.

U. piscis (Pl. 32. fig. 15 *a*) = *Oxytricha caudata*, Duj. Body terete, subturbinate, gradually narrowed behind into a tail; internal granules green; length 1-288 to 1-144″.

U. lamella (Pl. 32. fig. 15 *b*). Body depressed, hyaline, linear-lanceolate, flat and very slender; length 1-216″. Other species. (Ehrenberg, *Inf.* 358; Kent, *Inf.* 779.)

UROM'YCES, Lk.—A supposed genus of Uredinei (Coniomycetous Fungi), perhaps not properly separated from *Puccinia*, but distinguished from the ordinary state of that genus by the unilocular spores of the perfect fruit (see Uredinei and Puccinia). The genus *Pileolaria*, Cast., does not appear to differ from *Uromyces* in any essential particular. The *Uromycetes* are rusts occurring upon leaves, presenting at least two forms of fructification (*spermogonia* have not yet been observed), viz. 1. *Uredo-fruits*, consisting of stylospores unaccompanied by paraphyses, which have been described as species of *Trichobasis*, Lév.; and 2. the perfect fruit, resembling that of Puccinia, but with unilocular spores, unaccompanied by paraphyses. *U. ficariæ*, Lév. (*Uredo ficariæ*, Alb. & Schw.) is not uncommon on Ranunculaceæ, *U. appendiculatus*, Lk. (*Uredo appendiculosa*, Berk.), on various Leguminosæ.

Bibl. Berk. *Br. Fl.* ii. pt. 2. 380, 382; Tulasne, *Ann. Sc. Nat.* 4. ii. 145 & 185; Léveillé, *ib.* 3. viii. 370; De Bary, *Brandpilze*, 33.

URONE'MA, Duj.—A genus of Holotrichous Infusoria.

U. marina (Pl. 32. fig. 16). Body colourless, semitransparent, nodular, and with four or five faint longitudinal ribs; mouth ventral, with a trap-like velum; marine; length 1-570″.

Bibl. Duj. *Inf.* 392; Clap. & Lach. *Inf.* 271; Kent, *Inf.* 546.

URONYCH'IA, Stein.—A genus of Hypotrichous Infusoria. Oval-oblong, with a carapace, truncate in front, with a membranous upper lip, with posterior hooks; mouth excavated, with a band-shaped undulating membrane.

U. transfuga = *Plæsconia scutum*, Duj. Salt water. (Stein, *Inf.*; Kent, *Inf.* 797.)

UROP'ODA, Latr.—A genus of Arachnida, of the order Acarina and family Gamasea.

Char. Palpi and rostrum inferior; dorsal shield consisting of a single, broad, circular or oval piece; legs nearly equal; body frequently with a caducous anal peduncle.

U. vegetans (Pl. 6. fig. 25). Sixth joint of legs longest. The peduncle forms a horny filament, secreted from the anus, and serving to attach the body to Coleopterous insects, of which this animal is the parasite, although it is sometimes found under stones. Four other species, most of them doubtful.

Bibl. Dugès, *Ann. Sc. Nat.* 2. ii. 29; Gervais, *Walck. Apt.* 220.

UROSTY'LA, Ehr.—A genus of Hypotrichous Infusoria, fam. Oxytrichina.

Char. Body ciliated; styles present in a small cleft on the ventral surface; no hooks.

U. grandis (Pl. 32. fig. 17). Semicylindrical, subclavate, rounded at the ends, slightly thickened in front; freshwater; length 1-44 to 1-96″. (Ehr. *Inf.* 369; Cl. & L. *Inf.* 142; Kent, *Inf.* 797.)

UROT'RICHA, Cl. & Lachm.—A genus of Holotrichous Infusoria, family Trachelina. Free, ovate, with a long posterior saltatory cirrus.

Two species; freshwater. (Cl. & Lachm. *Inf.* 314; Kent, *Inf.* 504.)

URTI'CA, L.—A genus to which the stinging-nettle belongs (see STINGS).

US'NEA, Ach.—A genus of Ramalodei (Lichenaceous Lichens), with a somewhat crustaceous branched thallus, bearing peltate apothecia, which often have a ciliated margin. *U. barbata* is common on park-pales and old trees, *U. florida* and *plicata* in similar situations, mostly in mountainous regions. The pendulous fibrillous thallus and ciliated apothecia of *U. barbata* are very characteristic.

BIBL. Hook. *Br. Fl.* ii. pt. 1. 230; Leighton, *Lich. Fl.* 75.

USTILAGIN EÆ.—A family of Hypodermous Fungi related to the Uredinei, generally distinguished by their growing in the interior of the organs (especially the ovaries and anthers) of Flowering Plants, causing deformity, absorption of the internal tissue, and its replacement by a pulverulent substance consisting of the spores of the Fungi. In the earlier stages, the infected organ exhibits either a grumous mass, or an interwoven filamentous mycelium, from which acrogenous spores arise; finally the mycelium disappears, and a dark-coloured (often fœtid) powder remains, composed entirely of the spores, which are simple, or

Fig. 781. Fig. 782. Fig. 783.

Fig. 784. Fig. 785.

Thecaphora deformans.
Compound spores, entire and broken up.
Magnified 460 diameters.

more rarely compound (figs. 784, 785), *i. e.* several coherent within a common coat, at length free (figs. 781–783), smooth or unequally echinate or reticulated.

BIBL. Berk. *Br. Fl.* (art. *Uredo*); Tulasne, *Ann. Sc. Nat.* 3. vii. 5, ii. 157; De Bary, *Brandpilze*; Bauer and Banks, *Curtis's Pract. Obs. on Br. Grasses*, 1805; Unger, *Exanthem. Plant.*; Fischer v. Waldheim, *Ustilaginei.*

USTILA'GO, Fries.—A genus of Ustilaginei (Hypodermous Fungi), forming

Fig. 786. Fig. 787.

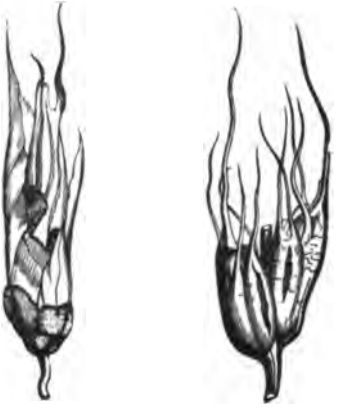


Fig. 786. Ustilago Carbo, on oats. Nat. size.
Fig. 787. Ustilago Carbo, on barley. Nat. size.

smuts, infesting the ears of corn and other grasses, the ovaries and anthers of other Flowering Plants, and in some cases the leaves and stems of plants. The interior of the organ infested by them presents at first a grumous-mucous whitish mass, which grows at the expense of the tissue and juice of the infested organ, and is finally converted into a pulverulent mass of simple spores, mostly of deep colour, and with a smooth, spiny or reticulated surface.

The species growing upon leaves and stems occur on grasses, *e. g. U. longissima* (*Uredo longissima*, Sow.), *U. hypodytes* (*Ur. hypodytes*), and *U. grandis* (or *typhoides*); they form linear patches, ultimately containing smooth black spores.

The greater number, however, occur in the parts of flowers, especially of grasses—*Ust. Carbo* (*Uredo segetum*, Pers.), forming the blight called smut of corn, commonly infesting wheat, oats (fig. 786), barley (fig. 787), and other grasses, filling the ears with a black powder of smooth spores, about 1-5000″ in diameter in corn, sometimes about twice as large in the varieties attacking species of *Bromus*. The smut of

maize (*U. maidis*, fig. 788) has minutely echinate spores, 1-2500″ in diameter.

It is curious that when *U. Antherarum* attacks a dicœcious plant, as *Lychnis dioica*, it causes the abortive stamens to be developed, and then finds its place in the new anthers.

Sedges are infested by *Ust. urceolarum* with dark-brown and *Ust. olivacea* with olive-coloured spores (*Uredines*, Br. Fl.).

Fig. 788.

Portion of a spike of Maize infested with *Ustilago maidis*. Some of the lower grains perfect and mature: above these, female flower with abortive ovaries. The projecting bodies are grains which have become deformed by the *Ustilago* developed within them.

Ust. antherarum, growing in the anthers of Caryophyllaceæ, has violet-coloured spores. Many other species are described by Tulasne, several of which have occurred in Britain.

Bibl. Tulasne, *Ann. Sc. Nat.* 3. vii. 73, 4. ii. 157; Berk. *Br. Fl.* art. *Uredo*; *Ann. N. H.* 2. v. 463.

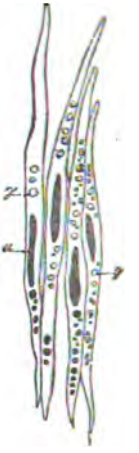
UTE'RIA, Mich. See Thyrsoporella.

U'TERUS.—The substance of the uterus consists of longitudinal, transverse, and oblique unstriated muscular fibres, interwoven with imperfectly developed areolar tissue resembling that in the stroma of the ovary.

Three layers of muscular fibres are described, but they are intimately connected. Those in the cervix are principally transverse or circular; and immediately beneath the mucous membrane at the mouth of the uterus, the transverse fibres form a sphincter.

The muscular fibres are from 1-600 to 1-400″ in length, fusiform, with elongate-oval nuclei, and very difficultly separable on account of the large amount of areolar tissue intermingled with them.

Fig. 789.



Uterine muscular fibres, three weeks after parturition, treated with acetic acid. α, nuclei; γ, globules of fat. Magnified 350 diameters.

The epitheliumis simple and ciliated. The mucous membrane of the body has no papillæ, but here and there some folds, and contains numerous tubular or uterine glands resembling the Lieberkühn's glands of the intestines, their cæcal ends being simple, bifurcate, or spiral, and consisting of a basement-membrane with cylinder-epithelium.

In the cervix are situated glandular depressions of the mucous membrane, which secrete a transparent tenacious mucus; some of these are closed, and form the ovules of Naboth.

The lower third or half of the canal of the cervix contains papillæ covered with ciliated epithelium.

During gestation the uterine elements, especially the muscular fibres, as also the vessels and probably the nerves, become enlarged and more numerous, from new formation (fig. 790).

All three of the coats of the veins of the pregnant uterus contain muscular fibres. After parturition, many of the muscular fibres undergo fatty degeneration, and become absorbed (fig. 789).

Bibl. Kölliker, *Mikr. An.* ii.; Chrobak, *Stricker's Hist.* iii.

UVEL'LA, Bory, Ehr.—A genus of Flagellate Infusoria, fam. Monadina.

Char. Bodies without an eye-spot,

Fig. 790.

Muscular elements from a uterus at five months' gestation. *a*, formative cells; *b*, young, *c*, fully developed muscular fibres. Magnified 350 diameters.

moving by means of two flagelliform filaments, and aggregated into spherical revolving clusters.

U. virescens (Pl. 32. fig. 18). Bodies ovate, rounded at each end, with two lateral bright green bands. Diameter of clusters 1-288″, length of bodies 1-2016″; freshwater.

The life-cycle of a cercomonad.—One of the Uvellæ has been described by Dallinger and Drysdale. When mature it multiplies by fission for a period extending over from two to eight days. It then becomes peculiarly amœboid; two individuals coalesce, slowly increase in size, and become a slightly distended cyst. The cyst bursts, and incalculable hosts of excessively minute sporules are poured out, as if in a viscid fluid and densely packed; these are scattered, and slowly enlarging, acquire flagella. They become active, attain rapidly the parent form, and once more increase by fission.

Bibl. Dallinger and Drysdale, *Mn. Mic. Jn.* 1873; Ehr. *Inf.* 19; Duj. *Inf.* 300; Kent, *Inf.* 406.

UVIGERI'NA D'Orb.—A genus of hyaline Foraminifera, near *Polymorphina*. Shell made up of three series of inflated chambers, alternating irregularly on an elongate spire, often ribbed; orifice central, round, tubular, and lipped. The triserial alternation passes sometimes into a biserial and even a uniserial growth (*Sagrina*, restricted). *Uvigerina* is world-wide in its distribution, and goes back to the Middle Tertiary Period.

U. pygmæa (Pl. 23. fig. 8).

Bibl. D'Orbigny, *Ann. Sc. Nat.* vii. 269; Carpenter, *For.* 169; Parker & Jones, *Phil. Tr.* clv. 383.

V.

VAGINIC'OLA, Lamarck.—A genus of Peritrichous Infusoria, fam. Vorticellina.

Char. Bodies as in *Vorticella*, single or in pairs, in a membranous urceolate sessile sheath.

V. crystallina (Pl. 32. fig. 19) = *Cothurnia crystallina*. Sheath crystalline, urceolate, straight, internal granules green; length 1-218″.

Several species, salt and freshwater.

Bibl. Ehr. *Inf.* 295; Clap. & Lach. *Inf.* 126.

VAGINULI'NA, D'Orb.—A Stichostegian subgenus of *Nodosarina*, with oblique chambers.

V. badenensis, D'Orb. (Pl. 23. fig. 35).

Bibl. Williamson, *Foram.* 21 (*Dentalina*); Jones, Parker, and Brady, *Monogr. For. Crag*, 63.

VALKE'RIA, Flem.—A genus of Infundibulate Ctenostomatous Polyzoa, of the family Vesicularliidæ.

Char. Variously branched; cells oval, irregularly clustered; eight tentacles, but no gizzard.

V. cuscuta. Stem with subverticillate branches; cells in clusters or opposite pairs; on marine Algæ, shells &c.

V. uva. Stem creeping, irregularly branched; cells scattered.

V. pustulosa. Dichotomous or alternately branched; cells clustered, unilateral.

V. tremella. Cells very small and slender.

Bibl. Johnst. *Br. Zooph.* 373; Gosse, *Mar. Zool.* ii. 20; Hincks, *Polyz.* 551.

VALLISNE'RIA, Mich.—An aquatic genus of Angiospermous Flowering Plants, belonging to the family Hydrocharidaceæ. *V. spiralis*, a native of the South of Europe, occurring wild also in North America, India, &c., is commonly grown in jars for the sake

of observing the ROTATION in the leaves. This plant is dicœcious; and the specimens ordinarily found in cultivation are the pistillate forms, which often produce flowers, but the seeds, remaining unfertilized, never ripen; the plant increases rapidly, however, by runners, if in a healthy condition. We find it thrive well in any situation indoors near a window and not exposed to frost; but it attains a far larger size in water kept at a high temperature, as in *Victoria*-tanks in Botanic Gardens. It is necessary, when growing it in jars, not to keep too many or too large snails in the water, as they destroy the leaves. See ROTATION.

VALVULI'NA, D'Orb.—A genus of Arenaceous Foraminifera.

Typically it has a triserial, three-sided, pyramidal shell, with three chambers in a turn of its spire and a valved or tongued aperture. The trifacial compression disappears in a common trochoid form, which becomes scale-like and flat. If the chambers fail to make a coil, an obliquely semi-oval shell is produced, with a broad oblique septal plane and a large valve, which bridges over the crescentic aperture with bars. The triangular form sometimes becomes Buliminoid; and often takes on a uniserial growth (*Clavulina*, restricted), either cylindric, tricarinate, or five-angled. Numerous forms, recent and fossil. *V. austriaca* (Pl. 23. f. 20).

BIBL. Parker & Jones, *Ann. N. H.* 3. v. 467; Carpenter, *Foram.* 146; Brady, *Carb. For., Pal. Soc.* 1876, 81.

VAMPYRELLA, Hckl.—A doubtful genus of Radiolarian Rhizopoda. Body red, rounded, without nucleus or contractile vesicle, and with very slender pseudopodia. These animals perforate the cells of *Spirogyra* and *Gomphonema*, and feed upon their contents. In the encysted condition, they are stated to possess an outer nitrogenous and an inner cellulose coat.

BIBL. Haeckel, *Qu. Mic. Jn.* 1869, 33; *Schultze's Arch.* 1876, xii. 24.

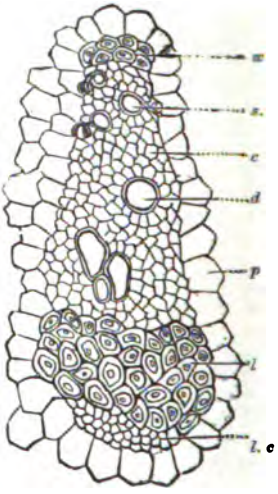
VARIOLA'RIA, Pers.—A spurious genus of Lichens, founded upon imperfect forms of PERTUSARIA &c.

BIBL. Hook. *Br. Fl.* ii. pt. 1. 172; Schærer, *En. Crit.* 229.

VASCULAR BUNDLES.—This title is applied to the fibrous cords which form the ribs, veins, &c. of the leaves, petioles and other appendicular organs of all plants ranking above the Mosses, and which by their confluence and more considerable development constitute the wood of stems and trunks. The vascular bundles of petioles (fig. 660, page 711), &c., running into leaves to form their ribs, and lying imbedded in parenchyma, resemble the bundles which form the rudiments of wood of the stem itself. The bundles remain isolated as fibrous cords in the stems of the herbaceous Monocotyledons, or are only combined into a wood, in the Palms &c., by the lignification of the cells of the parenchyma in which they are imbedded (fig. 461, p. 508).

In the Dicotyledons, the rudimentary bundles are developed in a circle surrounding the pith (fig. 455, p. 495), and soon unite to form a tube of wood, with an external cambium layer and a true bark; and the

Fig. 791.



Monocotyledon.

Transverse section of a fibro-vascular bundle of a Palm: the upper end is directed towards the centre of the stem. *w*, woody fibres resembling liber in structure; *s. v*, spiral vessels; *c*, cambium (*vasa propria*); *d*, ducts; *p*, parenchyma; *l*, liber; *l. c*, laticiferous canals. Magnified 150 diameters.

cambium layer is the seat of renewed development of the vascular bundle in each successive year. On such characters of growth, Schleiden founded a division of the vascular bundles into classes which are convenient in reference to microscopical investigations, and affixed tolerably perfect systematic characters to them.

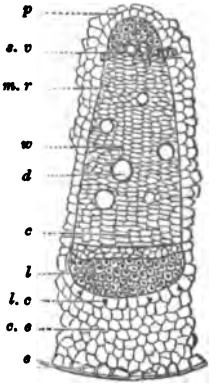
In the higher flowerless Plants, viz. Ferns, Equisetaceæ, &c., the vascular bundles are composed chiefly of ducts, sur-

rounded by elongated tubular cells, almost devoid of secondary deposits, the whole enclosed by a layer of tolerably firm prosenchymatous wood-cells, especially developed in the Ferns. In the Ferns, the ducts are mostly of the kind called *scalariform* (fig. 664, page 712; Pl. 48. fig. 10), in the Equisetaceæ *annular* (fig. 661, page 711), in the Lycopodiaceæ *spiral* (fig. 659, page 711; Pl. 48. figs. 11 & 12). They are variously arranged in the different orders, but agree in the mode of development, namely in growing only at the end next the *punctum vegetationis*, in proportion to the elongation of the stem and the evolution of leaves. Hence Schleiden called them *simultaneous bundles*; their various elements—ducts, tubular and prosenchymatous cells—being formed simultaneously.

In the Monocotyledons, where the vascular bundles occur isolated, they originate in the *punctum vegetationis*, and are developed with the growth of the stem, outwards and upwards into the leaves, and outwards and downwards towards the permanent circumference of the stem, old and new bundles crossing each other in a more or less complicated manner (fig. 461, page 508). Here (fig. 791) the first trace of the vascular bundle consists of spiral vessels, followed on the outer side by spiral, annular, or reticulated ducts; next comes a collection of elongated tubular cells of delicate structure (*vasa propria*), and in the outer part, at first, a *cambium* region, which is gradually converted into prosenchymatous woody structure having the character of LIBER-cells. In this case, the development is not only gradual from the *punctum vegetationis* outward, but the inner side of each bundle is perfected first, and the conversion of the outer part into wood occupies a whole season of growth. Hence these are entitled *progressive bundles*; but as no new development occurs in these in successive seasons, they are further distinguished from those of the Dicotyledons as *definite* bundles. The structure of the vascular bundles of Monocotyledons is very well seen, in different characteristic conditions, in vertical and horizontal sections of the stems of the white lily, of the large grasses, rhizomes of sedges and rushes—affording well-developed examples in herbaceous structures; of the bamboo (an arborescent grass), of the common cane or the partridge cane (both species of Palms), where the bundles are connected by lignified parenchyma. In leaves of bulbous Monocotyledons, &c., the bundles consist chiefly of spiral vessels; in the palms, bananas, &c., the woody fibre extends also into the ribs of the foliaceous organs.

In the Dicotyledons, the bundles of the stem appear first as a circle of cords composed of spiral vessels, around the pith, outside which larger vessels and ducts, and subsequently woody fibre or wood-cells are developed, passing into the elongated prosenchymatous liber (fig. 792). The development of the successive regions is *progressive* during the first season; but here the *cambium* layer remains capable of renewed activity, and a new layer of wood (and of liber) is added on the outside of the bundle in each successive season; hence these bundles are distinguished as *indefinite*. These may be observed in sections and young shoots of any common tree (figs. 455 & 457, pages 495 & 496).

Fig. 792.



Dicotyledon.

Transverse section of a fibro-vascular bundle of a Melon stem; the upper end next the centre of the stem. *p*, pith; *s. v*, spiral vessels; *m. r*, medullary rays; *w*, wood; *d*, pitted ducts; *c*, cambium; *l*, liber; *l. c*, laticiferous canals; *e. e*, cellular envelope of the bark; *e*, epidermis. Magnified 50 diameters.

Infinite variety of modification occurs in the character and arrangement of the vascular bundles within the limits above laid down, or very slightly overstepping them. A few remarkable cases may be mentioned here; in the Orobanchaceæ (parasites) no spiral vessels occur in the vascular bundles forming the wood; in *Victoria regia* the isolated bundles are composed of spiral vessels without any prosenchymatous wood-cells; other peculiarities, influencing more

especially the characters of WOOD, are given under that article. Vasculose, the substance of which vessels are formed, is insoluble in hydrochloric and sulphuric acid, and in copper solution, but is soluble in boiling caustic potash. (See also CAMBIUM and MEDULLA.)

BIBL. Henfrey-Masters, *Bot.*; Sachs, *Bot.*

VASIC'OLA, Tatem.—A genus of Heterotrichous Infusoria. Ovate, pointed behind; mouth anterior, surrounded by long cilia; contained in a transparent carapace.

V. ciliata; pond-water. (Tatem, *Mn. Mic. Jn.* i. 117; Kent, *Inf.* 613.)

VAUCHE'RIA, D.C.—An important and to the microscopist a most interesting genus of Siphonaceæ (Confervoid Algæ), consisting of green filamentous plants growing in fresh and salt water and on damp ground, characterized by the continuity of the cavity throughout the branched tubular filament (sometimes several inches long) of which each plant is composed, and by the modes of reproduction, both by gonidia and by spores. *Vaucheriæ* may be gathered on damp borders in every garden, or by the sides of ditches, where they form fine silky green tufts; they are very variable in form and size, so that the specific distinctions heretofore laid down appear to be worth little. The ordinarily occurring species presents itself as a tubular cell of comparatively gigantic dimensions, containing more or less protoplasm, coloured by chlorophyll in the form of minute granules applied upon the wall or occupying more or less of the cavity. The green granules may be seen to lie imbedded in a colourless protoplasm at the inner surface of the cellulose wall; and it is curious to observe when the filament is accidentally or intentionally ruptured that the green granules which may escape are contained in a mucous investment, which soon rounds itself into a globular body, of size proportionate to the quantity of green granules extruded; these globules sometimes even exhibit a slight rolling movement, but they appear ultimately to decay. Such globules sometimes occur inside the filaments, when the growth is unhealthy; and Itzigsohn calls them *spermatospheres*, stating that they produce spermatozoids. This, like all this author's observations, requires confirmation.

If the *Vaucheria*-filaments are gathered at a favourable epoch, or if they are cultivated in a vessel of water well exposed to light, the blind ends of the filaments (or rather of the ramifications of the filament) are found very densely filled with green contents, appearing almost black; and if these ends are watched early in the morning, a remarkable series of phenomena is observed in them. The ends of the filaments about to produce gonidia are found swollen into a slightly clavate form; the green contents of the club separate from the general contents of the filament, leaving a transparent space (fig. 793); then, having as it were acquired a definite independence, the isolated mass returns so as to fill up the transverse light space, but does not again coalesce with the lower mass of contents. Next, a light space is observed between the surface of the terminal body of contents and the cellulose

Fig. 793.

Fig. 794.

Vaucheria Ungeri.

Fig. 793. End of a filament in which a gonidium is being developed.
Fig. 794. Gonidium escaping from the filament.

Magnified 50 diameters.

wall surrounding it; and the latter soon gives away at the apex, forming a passage for the escape of the contents. This mass of contents is now clearly recognizable as the *gonidium* or zoospore; it gradually extricates itself from the tube, with a rotatory motion around its own axis; and it exhibits a remarkable elasticity of structure, giving way and altering its form (fig. 794) to squeeze through the narrow orifice of escape. Sometimes it becomes "pinched" in this process into two independent gonidia of half the usual size. As soon as it has perfectly emerged, it assumes an elliptical form, increases much in size, and is seen to be covered with innumerable vibratile cilia (fig. 796), arising from its gelatinous (protoplasmic) coat (these are rendered much more distinct by applying tincture of

iodine): no cellulose membrane exists at this time; and the gonidium swims about actively inth e water, revolving on its long axis. The large number of cilia existing on

Fig. 795. Fig. 796.

Vaucheria Ungeri.

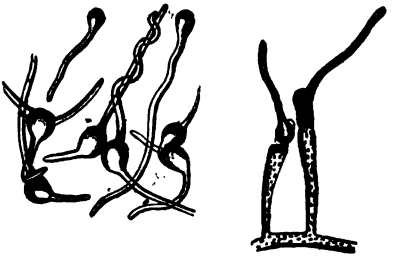
Fig. 795. End of the filament from which the gonidium has escaped. Magnified 50 diameters.
Fig. 796. Gonidium which has been treated with iodine and dried between two slips of glass, showing the cilia very clearly. Magnified 110 diameters.

this gonidium distinguish it remarkably from all others; but we are inclined to believe that there is a nearer relationship than appears at first sight. The green substance at the surface of the gonidium presents a peculiar granular or globular appearance; and it appears not far-fetched to regard this body as composed of a densely combined family of ordinary two- or four-ciliated zoospores, such as would be formed by the swarming-spores of *Hydrodictyon* if they remained in their primitive crowded condition. This, however, is a point requiring further examination. The end of the tube from which the gonidium has escaped appears as a hyaline sac (fig. 795), which soon decays down to the point where the contents parted, where a septum, now closing the tube, is developed.

After swimming about for some time, from one to several hours (usually about two), the gonidium falls to the bottom of the vessel, its cilia disappear, and it assumes a spherical form, acquiring very soon a distinct cellulose coat; after this it soon germinates by pushing out one or more tubular processes (fig. 797), which grow up into filaments like the parent. Sometimes the gonidium cannot make its escape; sometimes half of it escapes and becomes pinched off, the other half being left behind: in these cases, the arrested body, or the remaining portion of the divided one, germinates *in situ* (fig. 798).

It should be mentioned that the contents of the vegetative filaments have a remarkable tenacity of life; for if the tube is slightly

Fig. 797. Fig. 798.



Vaucheria Ungeri.

Fig. 797. Gonidia germinating. Magnified about 15 diameters.
Fig. 798. Filament with gonidia germinating in the parent tube; the left-hand figure, half a divided gonidium. Magnified 25 diameters.

injured at any point, the primordial utricle commonly retracts from the wound, and secretes a cellulose layer on its surface, shutting off the injured part. Filaments are sometimes met with having several living regions of this kind, shooting out into branches, separated from each other by dead, empty lengths of the filament.

Besides the vegetative reproduction above described, the *Vaucheriæ* are reproduced by spores formed by the concurrence of two distinct kinds of reproductive organs. Filaments growing on damp ground ordinarily exhibit lateral organs of two kinds, associated together, but variously grouped and collected in varying numbers at particular points, apparently according to external conditions. The larger kind of organ, or sporangium, appears first as a pouch-like process, which expands into a short flask-shaped body, stalked or sessile, the neck of which is gradually turned over in the development, until it projects at one side; the form then somewhat resembling that of a bird's head (or a chemist's glass retort cut off short at the neck, Pl. 5. fig. 12 A, B, *s*). Near this, on the main filament, or on a common pedicel with one or more of the sporangia, is developed another organ, the antheridium, at first straight and tubular, but soon curving over into the form of a hook or scroll, without however expanding (Pl. 5. fig. 12 A, B, *a*). The sporangium becomes filled with dense green granular matter, and cut off by a septum from the main filament.

The upper part of the antheridium is likewise cut off by a septum; and when mature it bursts at the apex and discharges biciliated spermatozoids resembling those of *Fucus*, which enter the simultaneously opened neck of the sporange and fertilize its granular contents. The contents become isolated from the wall, secrete a proper coat, and form a free cell (spore) lying in the sporange, its green granular matter gradually becoming brown (Pl. 5. fig. 12 c). Two coats, at least, are developed; and the spore ultimately escapes by the decay of the parent filament and sporange. According to Pringsheim, about three months elapse before germination, in which process the outer spore-coat splits, and the inner grows out into a tube, forming the basis of a new ramification of the *Vaucheria*-filament.

In the systematic works on Algology, numerous species of aquatic and land *Vaucheriæ* are described; but we agree with Thuret in believing that the characters by which most of the forms are distinguished are unessential, therefore we omit any synopsis of them. Even *V. racemosa*, Decaisne, appears merely an extreme of the kind of development producing *V. geminata*. Thuret proposes the name *V. Ungeri*, to include all but *V. racemosa*; Hassall suppresses the name *V. clavata*, as indicating a form common to all the species, of which he describes a large number. We do not find any thing sufficiently distinctive in the characters of the marine species cited by Harvey.

Bibl. Vaucher, *Conferves d'eau douce* (Ectosperma); Hassall, *Alg.*; Harvey, *Mar. Alg.* 195; Unger, *Nova Acta*, xiii. 11, *Die Pflanze im Mom. der Thierwerdung*, 1843; Decaisne, *Ann. Sc. Nat.* 2. xvii. 430; Thuret, *ibid.* xix. 266; Karsten, *Bot. Zeit.* x. 85, xv. 1; Pringsh. *Ber. Berl. Ak.* 1855; *Ann. N. H.* 2. xv. 346; Braun, *Verjüng.* (*Ray Soc.*), *Alg. unicell.*, 8, 105; Nägeli, *Neues Algensyst.* 175, pl. 4; Itzigsohn, *Bot. Zeit.* xi. 225; Dippel, *Flora*, 1856, 481; Rabenht. *Alg.* iii. 267; Sachs, *Bot.* 275.

VEGETABLE IVORY.—This substance consists of the seeds of the Palm called *Phytelephas macrocarpa*, and is composed of a large round mass of bony Albumen, in which a small embryo is imbedded. Slices of this ivory-like albumen, placed under the microscope, afford very beautiful examples of vegetable cells with the cavities almost obliterated by Secondary deposits (Pl. 47. fig. 23).

VEGETABLE KINGDOM.—The large number of Natural Orders of Angiospermous Flowering Plants, and the subordinate characters of their diversities in microscopic structure, lead us to depart from the plan on which the Synopsis of the Animal Kingdom is given and carry it into effect here only in reference to the Cryptogamic plants. For the microscopic phenomena in the Phanerogamia described in this work, reference should be made to the articles Embryo, Ovule, Tissues, Wood, &c.

Kingdom VEGETABILIA.

Subk. 1. **Phanerogamia.** Flowering plants.

- Division 1. *Angiospermia.*
  - Class I. Dicotyledons.
    - Most common trees and herbs.
  - Class II. Monocotyledons.
    - Grasses, rushes, most bulbous plants, palms, &c.
- Division 2. *Gymnospermia.*
  - Class III. Coniferæ.
    - Firs, pines, yew.
  - Class IV. Cycadaceæ.
    - Cycas, Zamia.

Subk. 2. **Cryptogamia.** Flowerless plants.

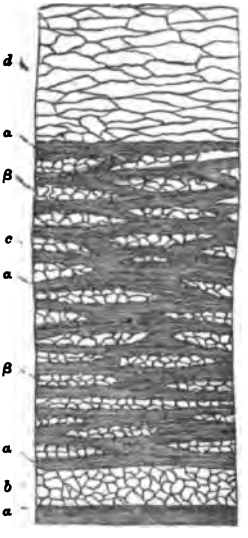
- Division 1. *Cormophytes* or *Acrogens.*
  - Class I. Lycopodiales. } Vasculosæ.
    - Order 1. Marsileaceæ.
      - Pilularia, Pill-wort.
    - Order 2. Lycopodiaceæ.
      - Club-mosses.
  - Class II. Filicales. } Vasculosæ.
    - Order 1. Filicaceæ.
      - Ferns.
    - Order 2. Equisetaceæ.
      - Horse-tails.
  - Class III. Muscales.
    - Order 1. Muscaceæ.
      - Mosses.
    - Order 2. Hepaticæ.
      - Liverworts and Scale-Mosses.
    - (Order of uncertain place, Characeæ.)
- Division 2. *Thallophytes.*
  - Class I. Algæ.
    - Order 1. Florideæ.
      - Red sea-weeds.
    - Order 2. Fucoideæ.
      - Olive sea-weeds.
      - (Phæosporeæ.)
    - Order 3. Confervoideæ.
      - Green silk-weeds, slime-weeds, and brittle-weeds (Diatomaceæ).

Class II. LICHENS.
Class III. FUNGI.
Order 1. SCHIZOMYCETES.
Bacterium, Vibrio.
Order 2. PHYCOMYCETES.
Moulds and mildews.
Order 3. HYPODERMIÆ.
Uredineæ, Ustilagineæ, smuts, &c.
Order 4. BASIDIOMYCETES.
Mushrooms, toad-stools, puff-balls.
Order 5. ASCOMYCETES.
Truffles, morells, &c.
Order 6. MYXOMYCETES.
Trichia, Æthalium, Lycogala.

BIBL. Lindley, *Veg. Kingdom*; Endlicher, *Gen. Plant.*; Fries, *Summa Veget. Scan.*; Henfrey-Masters, *Elem. Course*; Sachs, *Lehrb. Bot.*

VEINS OF ANIMALS.—The walls of the veins are thinner than those of the arteries, which arises principally from the less development of the contractile and elastic elements. The inner coat is less developed, but otherwise agrees with that of the arteries in structure. The middle coat is not yellow, but greyish red, containing more connective tissue and fewer elastic fibres and muscles; in addition to the transverse, it has longitudinal layers. The outer coat is usually the thickest, agreeing with that of the arteries, except that in many veins, especially those of the abdominal cavity, it contains well-developed longitudinal muscular fibres.

Fig. 799.



Longitudinal section of the vena cava inferior, near the liver. *a*, inner coat; *b*, middle coat without muscular fibres; *c*, inner layer of the outer coat—*a*, its longitudinal muscles; *β*, its transverse areolar elements; *d*, outer portion of the outer coat, without muscles. Magnified 30 diameters.

The veins of the brain, the bones, retina, &c., contain no muscular fibres.

The large veins, near the heart, contain transverse striated muscular fibres.

BIBL. Kölliker, *Hist.* ii.; Eberth, *Stricker's Hist.*; Frey, *Hist.*

VEINS OF PLANTS. — The name commonly applied to the ramifications of the VASCULAR BUNDLES, forming the ribs of leaves and similar organs.

VENILI'NA, Gümbel. See TEXTULARIA. (Gümbel, *Tr. Munich Acad.* cl. 2. x. 648).

VERMES.—A subkingdom of the ANIMAL KINGDOM.

VERMICULA'RIA, Fr.—A genus of Sphæronemei (Coniomycetous Fungi), but seemingly stylosporous states of Sphæriacei, most of the species being included under *Sphæria* in the British Flora. They grow on decaying stalks, leaves, or wood. *S. relicina, Dematium, culmifraga, trichella,* and others of the Br. Fl. belong here. Another species, *V. atramentaria,* is common on decaying potato-stems, forming black velvety patches. This is distinguished from *V. Dematium* by its straight spores. The erect black hairs of the perithecia are characteristic.

BIBL. Berk. *Br. Flor.* ii. pt. 2. 274, &c., *Ann. N. H.* 2 v. 378; Fries, *Sum. Veg.* 419.

VERMILION, or bisulphuret of mercury, is used as a pigment for injecting. It should be in a finely divided state, in which it is best obtained by levigation, and should not exhibit any white crystalline particles when examined as an opaque object.

VERNEUILI'NA, D'Orb. See TEXTULARIA.

VERRUCA'RIA, Pers.—A genus of Pyrenodei (Lichenaceous Lichens), containing numerous species having a crustaceous or cartilagineo-membranous thallus growing upon and adherent to the bark of trees or stones; named from the wart-like processes corresponding to the perithecia, which open by a pore at the surface. The perithecia have a black rind, enclosing either the whole or the upper half of the nucleus. The spermogonia much resemble the peri-

thecia, only they are much smaller; they occur either scattered among the perithecia, or collected towards the margins of the thallus. Species very numerous.

Bibl. Hook. *Br. Fl.* ii. pt. 1. 152; Leighton, *Lich. Fl.* 444; Schærer, *Enum. crit.* 213; Tulasne, *Ann. Sc. Nat.* 3. xvii. 215, pl. 3.

VERTEBRALI'NA, D'Orb.—A genus of Porcellaneous Foraminifera, near *Miliola*.

Char. Shell free, regular, greatly compressed, mostly inequilateral, more convex on one side than on the other, suborbicular or elongate; spire embracing in the young state only, afterwards straight; *chambers* in the spire, two or three; *orifice* a large patulous aperture along the septal plane. See Articulina and Renulites.

One recent British species:

V. striata (Pl. 23. fig. 10).

Bibl. Williamson, *Rec. For.* 89; Carpenter, *Introd. For.* 72.

VERTICIL'LIUM, Nees.—A genus of Mucedines (Hyphomycetous Fungi), distinguished from *Botrytis* (under which it is included, with *Acrostalagmus*, by Fries) chiefly by the verticillate arrangement of the sporiferous branches. A number of species are described; but, from the observations of Hoffmann and Bail on the germination of *Tricothecium*, this genus represents only one form of the plants belonging to other genera,—*V. ruberrimum*, Bonorden (*Botrytis verticilloides*, Corda, which Hoffmann regards as identical with *Acrostalagmus parasitans* and *cinnabarinus*), having been raised from the spores of *Trichothecium roseum*, and its "spores" being barren (see Trichothecium). Berkeley and Broome describe and figure several new species.

Fig. 800.

Verticillium cylindrosporum. Magnified 200 diameters.

Bibl. *Ann. N. H.* 2. vii. 101, pl. 7. figs. 15–18; Fries, *Sum. Veg.* (*Botrytis*), 491.

See also Trichothecium.

VESICULA'RIA, Thomps.—A genus of Infundibulate Ctenostomatous Polyzoa, of the family Vesicularidæ.

V. spinosa, the only species, general on marine shells, &c.

Bibl. Thompson, *Zool. Illustr.* 98; Johnston, *Br. Zooph.* 370; Hincks, *Polyz.* 512.

VESICULARI'IDÆ.—A family of Infundibulate Ctenostomatous Polyzoa.

Char. Polypidom plant-like, horny, tubular; cells free, deciduous, the ends flexible and invertile. Genera:

Serialaria (*Amathia*). Shoots slender, filiform, erect, branched; cells tubular, adherent, uniserial and unilateral, rows interrupted by blank intervals; tentacles eight.

Vesicularia. Shoots branched, jointed; cells oval, distinct, uniserial and unilateral; eight tentacles, and a gizzard.

Valkeria. Variously branched; cells oval, irregularly clustered; eight tentacles, no gizzard.

Mimosella. Variously branched; cells ovate, in two rows, opposite, jointed at the base; eight tentacles and a gizzard.

Avenella. Filiform, creeping, nearly simple; cells large, solitary, scattered, in one row, slightly contracted at the top, curved; twenty to twenty-four tentacles, and a small gizzard.

Nolella. Cells erect, subcylindrical, crowded on tubes which form an undefined incrusting mat; tentacles eighteen.

Bowerbankia (Pl. 18. fig. 19). Matted and creeping, or erect and irregularly branched; cells tubular, densely clustered; tentacles eight to ten, and a strong gizzard.

Farrella. As *Bowerbankia*, but tentacles twelve to thirty, and no gizzard.

Anguinella. Branched palmately, one tube springing from another, largely composed of mud; animals with twelve tentacles and no gizzard.

Bibl. Johnston, *Br. Zooph.* 367; Gosse, *Mar. Zool.* ii. 19; Hincks, *Polyz.* 512.

VES'PA, Linn.—*Vespa vulgaris*, the wasp, and *V. crabro*, the hornet, are readily accessible insects for the examination of the sting (Sting).

VESSELS of Animals. See Arteries, Lymphatic system, and Veins.

VESSELS of Plants.—This name was applied by the earlier observers to various elongated tubular structures of vegetable tissues, from an idea that they corresponded with the vessels of animals; and the name is still retained. The *spiral*, *annular*, &c. vessels are described under Spiral Structures. The term *vessel* is now generally contrasted with duct, to indicate a single long tubular cell, or row of confluent elongated cells, with *spiral* secondary deposits upon their walls, in contradistinction to a canal formed of a row of cells, with *pitted*

secondary deposits, applied end to end and confluent. The LATICIFEROUS tubes are sometimes called laticiferous or milk vessels.

VIB'RIO, Müll.—A genus of Schizomycetes.

Char. Filiform, more or less distinctly jointed from imperfect division; flexible, movement undulatory, like that of a serpent.

These filamentous bodies are extremely minute; their simple structure is best seen when they are dried.

V. rugula (Pl. 7. fig. 19). Filaments hyaline, distinctly jointed, very tortuous when in motion. Warming describes a cilium. In decomposing infusions; breadth 1-12000″.

V. bacillus (Pl. 7. fig. 21). Filaments elongate, hyaline, joints sometimes distinct only after drying, flexuous in their slow motion; length 1-288″; breadth 1-1700″.

V. serpens. Smaller than the last, with three or four undulations. In infusions &c.

BIBL. Ehr. *Inf.* 77; Duj. *Inf.* 216; Rabenht. iii. 71.

Vibrio tritici = ANGUILLULA *tritici.*

VICTOREL'LA, Kent.—A genus of Ctenostomatous Polyzoa. Cells formed in open enlargements of the creeping stem; tentacles few; no gizzard.

V. pavida, very minute; on *Cordylophora lacustris,* in brackish water.

BIBL. Kent, *Qu. Mic. Jn.* 1870, 31; Hincks, *Polyz.* 559.

VILLI.—These are minute folds or prolongations of the mucous membrane of the small intestines. They are most numerous in the jejunum and ileum—in the former, conical and flattened, sometimes plate-like, cylindrical, club-shaped or filiform, while in the latter they are broader and flattened.

Fig. 801.

Fig. 802.

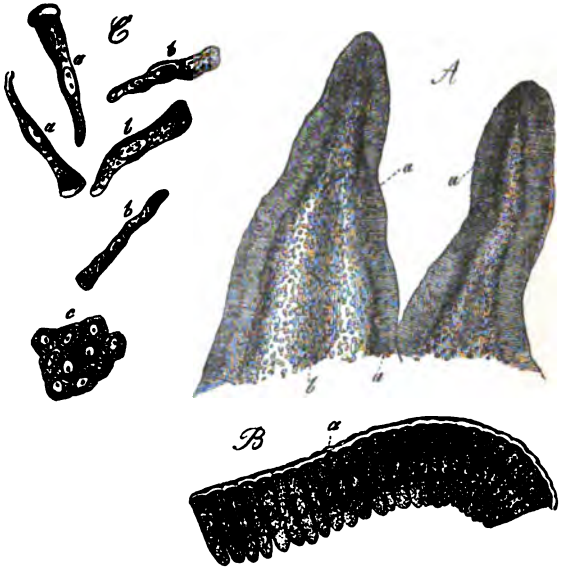


Fig. 801. Intestinal villus of a kitten, free from epithelium, and after treatment with acetic acid: *a*, boundary of villus; *b*, subjacent nuclei; *c*, nuclei of the muscular fibres; *d*, roundish nuclei in the middle of the villus. Magnified 350 diameters.

Fig. 802. *A*, magnified 75 diameters. Two villi with their epithelium, from a rabbit: *a*, epithelium; *b*, parenchyma. *B*, magnified 300 diameters. A row of detached epithelial cells: *a*, membrane separated by water. *C*, magnified 350 diameters. Detached epithelial cells: *a* with, *b* without the separated membrane; *c*, surface view of some epithelial cells.

The villi form solid processes of the mucous membrane, consisting of connective tissue without elastic elements, but abounding in roundish nuclei; containing also blood-vessels, lymphatics, and unstriated muscular fibres.

The villi are exceedingly vascular, and form beautiful microscopic objects when injected, exhibiting a network of capillaries with rounded or elongate meshes.

Fig. 803.

Fig. 803. Two villi from a calf, without epithelium, and containing each a lacteal vessel; after treatment with dilute solution of soda. Magnified 350 diameters.

Each villus contains a lacteal, the origin of which commences either in a single cæcal dilatation, or in a network of branches.

The muscular fibres form a thin layer, not very distinct in man, surrounding the lacteals, and capable of greatly contracting or shortening the villi.

The epithelial cells are intimately connected with each other, but easily detached from the villi, often in groups or rows; the free surface is longitudinally striated. When acted upon by water, the cell-membrane at the surface is separated, leaving a clear space between the granular cell-contents and the former.

Bibl. Kölliker, *Mikrosk. Anat.* ii.

VINCA, L.—The generic name of the garden plants called Periwinkles; interesting to microscopists on account of their striated liber-fibres (Pl. 48. fig. 30). See Spiral Structures.

Fig. 804.

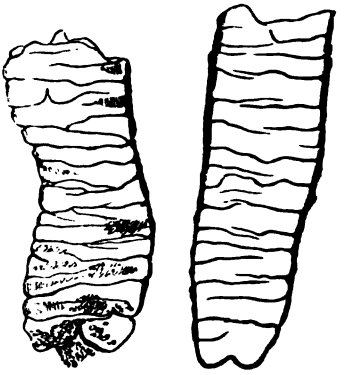


Fig. 804. Two contracted villi, from a cat. Magnified 60 diameters.

VINE-FUNGUS. — The vine-mildew, *Oidium Tuckeri*, Berk., which has in recent years caused such extensive destruction, has formed a subject of investigation for most of the principal mycologists; and notwithstanding that its natural history is not yet wholly cleared up, many interesting points have been discovered. As it ordinarily appears, it forms a white and very delicate cottony layer upon the leaves, young shoots, and fruit of the vine, soon causing a production of brown spots upon the green structures, and subsequently a hardening and a destruction of the vitality of the surface. Under the microscope, the white substance is seen to be composed of delicate ramified filaments, creeping horizontally over the surface, and, when the plant is much developed, forming a dense interlacement. The horizontal filaments exhibit few septa, these occurring at the points of branching, and they do not penetrate into the interior of the epidermal layer; here and there, however, they are found fixed to the epidermis by a more or less developed organ of attachment, consisting of a disk or lobed expansion, comparable roughly to the so-called root of some of the Fucoid Algæ, which adheres firmly to the cuticle, and when removed, leaves a brownish scar behind. The destructive effect of the Fungus seems to arise from its arresting the development of the epidermis, by binding its structures together, and excluding the sur-

face from the influence of the air, since when young berries are invaded, the internal development proceeds, and the sphacelated epidermis preventing the natural expansion, the grapes burst and rot. In this case, species of *Botrytis*, &c. appear upon the decomposing pulp, as on all similar substances; and these must be distinguished from the proper mildew. When full-grown leaves are affected to a moderate extent, the vitality is often only partially affected, causing a laxity of the tissue, and more or less fading of the green colour, without inevitable decay.

When the mildew is observed with a low magnifier, its surface exhibits a mealy appearance, arising from minute bead-like or pearly shining bodies of oval form; and the application of sufficient power shows that the horizontal filaments bear numerous erect branches or pedicels, consisting of short-jointed filaments (Pl. 26. fig. 8), the terminal cells of which (or the last two) are elliptical and expanded. These terminal cells are soon matured, and then fall off; vast numbers of them are produced, and are found lying upon the surface among the creeping filaments, where they quickly germinate (Pl. 26. fig. 9) and produce new ramifications of mycelium. The fungus, as thus described, constitutes the *Oidium* proper; and the deciduous terminal cells form the so-called *spores*. But the history of the development of the mildew does not cease here.

In the first place, the detached 'spores' do not always produce a filament as represented in fig. 9; some of them present, while still attached, a kind of segmentation of the protoplasmic contents (fig. 10); and detached examples are found filled with minute 'sporules' of elongated-elliptical form. These minute 'sporules' are either discharged by a dehiscence of the 'spore' (fig. 11), and then germinate, or sometimes they germinate *in situ* and send out slender filaments through the walls of the spore. We have found also that the large filaments produced by the simple large 'spore' (fig. 9) do not always at once form a regular mycelium, but sometimes give rise to slender pedicels, terminating in a point bearing minute solitary corpuscles of about the size and form of the 'sporules' above described, and resembling the *spermatia* of many of the higher Fungi.

In addition to this, we have sometimes observed those 'spores' which produce the 'sporules' in their interior, with their outer membrane finely punctate; and in very rare cases this form of fruit was not composed of a single terminal cell, but presented indications of cross septa, as if two or more cells of the summit of the pedicel were confluent into one sac; here the punctuation of the surface was very strongly marked.

Thus far we depend upon our own observations; but Mohl, Tulasne, and others describe a still more highly developed fruit than that last noticed: they have found the terminal body, producing 'sporules,' with a distinct cellular coat (Pl. 26. fig. 12), from which the sporules are discharged by a terminal dehiscence. Mohl found this body, very rarely, of spherical form. We have never seen this cellular coat; in the cases we have met with, the coat was certainly only punctate or tubercular; probably the structure was not mature, nevertheless the 'sporules' were distinctly evident.

These phenomena, exhibited by the Vine-fungus, clearly agree with those exhibited by the *Oidia* always accompanying certain Erysiphæ, as described under that article; and therefore most of the authors who have written on this subject conclude that the Vine-fungus is really an *Erysiphe*, of which the perfect, ascophorous fruit has not yet been discovered. A comparison of figure 12, Pl. 26, from the Vine-, copied from Mohl, with those of the Hop-*Erysiphe*, fig. 14, will show the agreement of structure between the two plants.

It remains only to add a few remarks as to the interpretation or nomenclature of the different organs. Mohl, Tulasne, &c. have denominated the simple 'spores' above described (figs. 8, 9) *conidia*; but as we have stated, the cells are convertible into what may be called *sporanges*, producing 'sporules' (or true spores) without alteration of structure. When their walls become cellular (fig. 12), the sporangial character is more decided; but as the *Erysiphæ* produce a more perfect *sporange*, in which *asci* are developed, the name of *pycnidia* is applied to them. This fruit it was which gave rise to the establishment of a supposed distinct genus, by Cesati, under the name of *Ampelomyces*; while Ehrenberg, also regarding it as a distinct plant, made it the type of a genus called *Cicinobolus*, on account of the peculiar tendril-like extrusion of the 'sporules' (fig. 12 *s*). Mohl distinguishes it as the *Cicinobolus*-fruit, which he, like Tulasne, finds constantly associated with other (un-

doubted) *Erysiphæ* (fig. 14), in very slightly different and equally irregular forms.

There can be no doubt whatever, that it is the cause and not a consequence of the 'murrain;' still there are various curious circumstances connected with it not at all understood. It is probable that peculiar atmospheric conditions induce predisposing states of the plants; but the phenomena are enigmatical: we have had it completely covering a vine in a small greenhouse, destroying all the fruit one year; and although no precautions were taken (as it was desired to study the disease), no sign of mildew appeared there the next year; while on an out-door trellis, a few yards off, the disease reappeared in a slight form in the second season. The application of sulphur appears to arrest the growth.

Bibl. Berkeley, *Gardener's Chron.* 1847, no. 48; *Jn. Hort. Soc.* vi. 284, ix. 61; Montagne, *Bull. Soc. Centr. Agric.* 2. v.; *Jn. Hort. Soc.* ix. 112; Amici, *Atti dell' Accad. de' Georgofili*, xxx., *Jn. Hort. Soc.* viii. 231; Savi, *ibid.* 241; Tulasne, *Bot. Zeit.* xi. 257; *Compt. Rendus*, xxxvii.; Thuemen, *Pilze d. Weinstocke*, 1878.

VINEGAR, Eels in. See Anguillula.

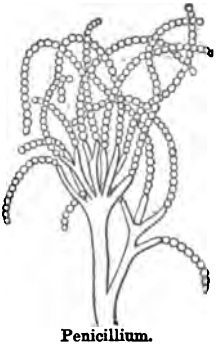
VINEGAR-PLANT.—Under this name is known a remarkable vegetable production formed in fluids rich in sugar, when undergoing fermentation at ordinary temperatures and conversion into vinegar. As ordinarily met with, it forms a tough gelatinous mass floating on the surface of the liquid, its shape (superficially) defined by that of the vessel in which it is contained, extending itself so as to occupy the whole surface even in very large pans,—its depth or thickness depending on its age and the amount of nutriment contained in the liquid. The gelatinous substance decreases in density from above downwards, the lower part being very lax and flocculent, the inferior surface being in a state of continuous development. The general mass, however, displays remarkable tenacity, which, together with its lubricity, renders it difficult to tear; but if the lower surface is examined, it is found possible to strip off layer after layer, each a few lines thick, to an extent depending on conditions of growth, the lower, less dense portion being thus distinctly stratified.

When portions are placed beneath the microscope, very varied forms of structure are discovered in the interior. The general mass of jelly appears structureless, as if formed by some exudation, or solution of the organized portion; but the mode of origin of this jelly is not yet ascertained. Imbedded in the jelly are cellular structures, polymorphous indeed, but exhibiting transitions which render it impossible to regard them as of distinct origin. In the middle portion often occur innumerable isolated masses of short rows of cells, resembling the cells of Yeast when coherent, except that they are generally elliptical; some of them have short cylindrical joints: others short cylindrical portions arising from long tubular filaments, and terminating in elliptical cells, so as to resemble exactly Oidium. The diameter of all these structures is most variable, from 1-4000 to 1-8000″. In the upper part, the elongated branched filaments more abound, the length of the internodes and the diameter of the tubes still varying extremely. At the lower, laxer surface, the cellular structures are accompanied by less of the tough gelatinous matrix. The lamination of the lower growing surface is very curious, but may perhaps be accounted for by supposing that the inferior growing surface of the mass, which is certainly the mycelium of a fungus, periodically produces a crop of *conidia*, which become detached and fall into the body of the liquid on which the mass floats; there quickly germinating, they form a new entangled mass of filaments and chaplets of cells, which then acquires its gelatinous consistence, and, buoyed up by the liquid, applies itself against the lower surface of the parent mass, with which it adheres, more or less, on account of the gelatinous condition. In the upper part of old and thick masses, the layers become inseparable—probably in some measure from the pressure of the floating force from below, together with the condensation arising from the evaporation of the liquid of the jelly at the upper surface.

When a vinegar-plant is left upon the solution after the saccharine matter is exhausted, we find it always display, after a certain time, patches of the ordinary fructification of Penicillium *glaucum* (fig. 805), as stated by Turpin and others, forming green, blue, and yellow "mould" upon the surface, and imbedded in the upper strata, in which also heaps of the spores occur; the vinegar sometimes ultimately suffers more or less decomposition, so that the common "mother" of vinegar, which by its growth destroys the acidity, appears to be another condition of this same organism. In some cases where we kept an

exhausted liquid in the dark for some months, the acidity of the vinegar disappeared, the gelatinous layer became greatly condensed, and assumed a bright crimson tint, and remained as a dull-red membranous film, somewhat like a smear of blood when dried upon paper.

Fig. 805.



Penicillium.
Head of a fertile filament bearing strings of spores. Magnified 250 diameters.

From the above observations it would appear that the vinegar-plant consists of the mycelium of *Penicillium glaucum*, vegetating actively and increasing also by crops of *conidia* or gemmæ. This opinion is entertained by Turpin, Berkeley, and other observers; and the various genera and species founded on the different forms of structure occurring in it cannot be entertained: among these are *Ulvina*, Kütz., and species of *Hygrocrocis*, *Leptomitus*, &c. But the moniliform growth is at the same time scarcely distinguishable from the Yeast-plant by any satisfactory characters; and repeated observations strongly impress us with the idea, that these objects are all referable to one species,—the vinegar-plant being the form of vegetative growth taking place at low or ordinary temperatures in highly saccharine liquids, while the true yeast-plant or *Torula* is formed in the more rapid fermentation taking place at more elevated temperatures. Another circumstance, mentioned under PENICILLIUM, is that we have found stale beer-grounds, kept at a rather low temperature, always ultimately acquire a gelatinous crust, on which *Penicillium*-fruit becomes developed.

In connexion with this subject may be mentioned the objects called *Cryptococcus glutinis*, Fres., and the "blood on bread," which appear nearly related to the red-coloured condition of the vinegar-plant above mentioned. These are possibly merely forms of the same plant; indeed we have observed, on some flour-paste partially covered with *Penicillium glaucum*, small circular patches of a crimson tint, which under the microscope were found to consist wholly of minute elliptical bodies, generally exhibiting two internal granules or "nuclei," and exactly resembling the articulations of some of the moniliform structures of the vinegar-plant, which readily separate into their component cells. All these phenomena require further investigation, to which long-continued and constant observation must be applied in order to ascertain with certainty the relation the different objects bear to each other. It is a kind of research occupying much time, and demanding great care and patience, but calculated to repay the trouble far better than the amassing of isolated characters of forms seen at different periods and under special conditions. Further particulars concerning various points treated in this article will be found under the heads FERMENTATION, OIDIUM, PENICILLIUM, TORULA, and YEAST.

BIBL. Turpin, *Mém. de l'Institut*, xvii. 135; Berkeley, *Jn. Hort. Soc.* iii. 91; Lindley's *Med. Bot.* 17; Fresenius, *Beitr. z. Mycol.* Heft ii. 77; Slack, *Tr. Mic. Soc.* 1865, 10.

VIRGULA'RIA.—A genus of Pennatulidæ (Alcyonaria). *V. mirabilis* is found in British seas, and has a long rod-like support to the short polype-bearing fringes.

VIRGULI'NA, D'Orb.—A subgenus of *Bulimina*, having outdrawn, very delicate, and smooth biserial shells, with extremely fine pores. The regular *Virgulinæ* are typified by *V. squamosa*, those of less regular growth by *V. Schreibersii*. The only variety taking on a sandy condition, becoming delicately rugose or subarenaceous, is *V. Hemprichii*, common in the Indian seas and in some Tertiary and Cretaceous strata, having muddy dull shells of very variable growth, and presenting passages of form between *V. Schreibersii* and *Bulimina* proper. See BOLIVINA and BULIMINA. Common, recent and fossil.

The extreme subcylindrical modification of *Virgulina* is *Pleurostomella*, Reuss; the bi-uni-serial modification is *Bifarina*, P.&J.

BIBL. Ehrenberg, *Mikrog.*; Parker&Jones, *Phil. Tr.* clv. 375; *Ann. N. H.* 4. ix. 284, 299.

VIS'CUM, Linn.—A genus of Loranthaceæ (Dicotyledons).

V. album is the mistletoe, alluded to under EMBRYO-SAC, LIBER, and OVULE.

VITREOUS HUMOUR or body. See EYE.

VITTÆ of the valves of the Diatomaceæ. —These are internal projections or inflections of the valves, forming imperfect septa; they appear as dark lines, visible under ordinary illumination.

VITTÆ OF FRUITS. See SECRETING ORGANS of Plants.

VITTA'RIA, Sm.—A genus of Grammitideæ (Polypodiaceous Ferns). Several species; tropical. (Hooker, *Syn.* 395.)

VOLUTELLA, Fr.—A genus of Stilbacei (Hyphomycetous Fungi), comprising several species of parasites which have been variously distributed. The plants consist of minute fleshy papillæ (*stromata*) of cellular structure, the surface of which is clothed with elliptic, oblong, or fusiform stylospores, from between which project long jointed hairs (fig. 806) traversing the stroma.

Fig. 806.

Volutella buxi.
Magnified 20 diameters.

It may be desirable to give the synonymy of these plants according to Berkeley and Broome.

V. ciliata, Fr. (*Psilonia rosea*, Br. Fl.). Whitish or rosy; on potatoes.

V. buxi, Berk. & Br. (*Fusisporium buxi*, Br. Fl.). White; on dry box-leaves (fig. 806).

V. setosa, Berk. & Br. (*Psilonia setosa*, Br. Fl., *Ægerita set.*, Grev.). White, on wood and herbaceous stems.

V. hyacinthorum, Berk. & Br. (*Psil. hyac.*, Br. Fl.). White; stipitate; on hyacinths grown in water.

V. melaloma, B. & Br. Orange, with black hairs; on sedges.

BIBL. Berk. *Br. Fl.* ii. pt. 2. 352–3; *Ann. N. H.* 2. v. 466, pl. 11. fig. 3; Greville, *Crypt. Fl.* pls. 102 & 268. fig. 2; Corda, *Ic. Fung.* ii. pl. 13. fig. 107; Fries, *Syst. Myc.* iii. 447.

VOLVOCIN'EÆ.—A family of Confervoid Algæ; they were formerly included among the Infusorial animalcules, among which they form one of Ehrenberg's families. The most striking general character of these objects is their composition of individual elements, which exhibit in their mature and most perfect stage of existence, the characters of the transitory ZOOSPORES of the other Confervoids. The Volvocineæ may be characterized as plants composed of a number of permanently-active zoospore-like bodies associated together into families of definite form, in which the members, connected or held together in various ways by cell-membranes, retain their distinct individuality for all physiological purposes of nutrition, growth, reproduction, &c., but represent only one being in relation to the surrounding objects. *Protococcus*, however, consists of only a single cell. The best-known and most beautiful example of this family is the genus *Volvox* (Pl. 7. fig. 24), consisting when mature of a spherical membranous sac, at the periphery of which, within the membrane, are arranged a large number of zoospore-like bodies (*gonidia*), each provided with a pair of cilia, which pass out through the enveloping membrane, collectively forming a coating all over the external surface, and by their vibration causing a rotary motion of the entire globe.

The modes of reproduction of the Volvocineæ, both vegetative and by spores, are described under PANDORINA, VOLVOX, and GONIUM; hence it is unnecessary to dwell on them here.

Char. Permanently active zoospore-like bodies, ciliated (except *Gyges*), surrounded by a gelatinous coat (like COCCOCHLORIS); solitary or combined in definite groups, with or without a common enveloping membrane. Individuals pyriform, or with the body prolonged posteriorly.

Solitary.
- Without cilia ..... *Gyges.*
- With a pair of cilia ..... *Protococcus.* (*Chlamidomonas.*)

Grouped.
- Forming a square layer, gonidia with two cilia ..... *Gonium.*
- Forming a spherical body.
  - Cilia solitary.
    - With a "tail" ..... *Uroglena*.*
    - Without a "tail."
      - Without an eye-spot, with special coats ... *Syncrypta*.*
      - With an eye-spot, gonidia dividing into clusters .. .. *Spherosira*.*
  - Cilia two.
    - Without an eye-spot... *Synura*.*
    - With an eye-spot.
      - Common envelope spherical.
        - Gonidia numerous, all over the periphery... *Volvox.*
        - Gonidia eight, in a circle at the equator..... *Stephanosphæra.*
      - Common envelope ellipsoidal, gonidia sixteen or thirty-two ..... *Pandorina.*

* Probably stages of development of VOLVOX or PANDORINA.

See SPONDYLOMORUM and SYCAMINA.

BIBL. See the genera.

VOLVOX, L.—A genus of Volvocineæ (Confervoid Algæ), of which only one species, *V. globator* (Pl. 7. fig. 24), seems satisfactorily established. This organism, occurring not uncommonly and often in great abundance in clear pools on open commons, &c., appears to the naked eye as a minute pale-green globule gently moving about in the water; its dimensions variable, but generally about 1-50″ when full-grown. When placed under a low magnifying power, it is found to be a spherical membranous sac or cœnobium, studded all over with green points, the entire body rolling over in the water with a motion which is readily discerned to be caused by innumerable cilia arranged upon the surface of the globe. In the interior of the sac are generally seen dense globes, in summer mostly of a green colour (Pl. 7. fig. 24): sometimes the cavity is wholly filled up by a number of membranous sacs exactly resembling the parent but deformed by mutual pressure (Pl. 7. fig. 25); and inside these are seen smaller green bodies as in the former case. The cœnobium is also flexible, yielding to pressure and recovering its form, and in full-grown specimens is generally ruptured at one point, where the internal bodies escape, so that the number varies; usually, however, the original number is eight.

The application of higher powers is requisite to discover the intimate structure of *Volvox*, which, by the researches of Williamson and Busk, most of whose observations we have verified, has been pretty clearly made out. The outer envelope consists of a layer of cell-membrane, in all probability composed of a modification of cellulose, although we have never succeeded in producing more than a faint purple tinge with sulphuric acid and iodine. By the application of a sufficient magnifying power, the green corpuscles at the periphery are found to consist of zoospore-like bodies (*gonidia*, Pl. 7. fig. 28), which are seated inside the membranous envelope, each sending out its pair of vibratile cilia (figs. 24–30) through separate orifices in the external coat. The same investigation will reveal that the green gonidia have radiating processes extending from their sides, and running from the different centres to meet each other in the light interspace, forming thus a kind of delicate network beneath the membrane. The gonidia are pyriform, have a transparent anterior end bearing a pair of cilia, and contain a reddish-brown eye-spot and a contractile vacuole, thus exactly resembling those of *Gonium*, and indeed the zoospores of Confervoids generally. The radiating processes resemble those found in particular stages of PROTOCOCCUS *pluvialis*, running through the gelatinous coat, and probably may be compared to the radiating filaments proceeding from the nucleus of SPIROGYRA (Pl. 9. fig. 26). There is somewhat more difficulty in determining the nature of the structure in which the gonidia are enclosed. There is a layer of soft consistence of some thickness within the external membrane; the green gonidia are wholly imbedded in this; and their radiating processes and cilia traverse the substance of it. We are inclined to believe that this presents a firm membranous layer again at the internal surface, looking toward the general cavity of the sphere. The nature of the soft layer has been the subject of discussion; we believe Busk's view to be correct, that it is not formed by the collocation of distinct membranous cells, like those of ordinary parenchymatous structures, but by the close juxtaposition of gelatinous envelopes of the individual green bodies, resembling those of *Coccochloris*, *Glœocapsa*, &c. We could never detect a true line of demarcation halfway between neighbouring gonidia: an appearance is indeed sometimes presented in preparations kept in chloride of calcium, which might lead to an error on this point; for the outer membrane is then sometimes swollen into papillæ opposite each corpuscle (Pl. 7. fig. 30), the furrows between which in certain foci give the appearance of a septum running round each corpuscle (Pl. 7. fig. 29). Similar preparations also often show the gonidium contracted and leaving an empty ring round it, separating it from the gelatinous coat, which runs undistinguishably into those of the neighbouring gonidia. But the strongest fact we have observed is that, by the application of solution of potash, the substance surrounding the gonidia is so entirely dissolved that the oily substance extracted from the green bodies will run freely about beneath the external membrane (apparently confined internally by another film), in sheets extending over considerable segments of the sphere, yet leaving the gonidia and their radiating processes intact, or at least only shrunk and discoloured. If a true cell-membrane existed around each gonidium,

forming septa dividing them, the above phenomenon could not display itself, since the potash would not so dissolve the structures.

The modes of reproduction of *Volvox* have recently been entirely elucidated. In certain conditions, some of the gonidia appear larger than the rest, and as if undergoing division (Pl. 7. fig. 27); it is possible that some of the gonidia, or of such grouped gonidia, escape into the cavity, and there become developed into the large green bodies (Pl. 7. fig. 24), which are rudimentary globes; but Williamson believes these are detached in an earlier stage: perhaps both modes of development take place. Forms with the grouped gonidia (Pl. 7. fig. 29) would appear to represent Ehrenberg's *Sphærosira*. Ehrenberg's genus *Uroglena*, again, would seem to be a *Volvox* either imperfectly developed or decaying.

The deep-green bodies (Pl. 7. fig. 24), seen in the cavity of the spheres, are young *Volvoces*, and in an early stage they appear as spherical cells filled with granular green substance; the green substance divides by segmentation (Pl. 7. figs. 31, 32) until it forms a group of gonidia, on each of which a pair of cilia appears, the enclosing membrane expands, and they follow it and remove apart, until they form a perfect *Volvox*-sphere, studded with the gonidia. As above mentioned, a second generation is sometimes met with in the parent sphere (Pl. 7. fig. 25). We are uncertain whether to regard the objects represented in Pl. 7. fig. 14, as the young of *Volvox*; they would seemingly equally represent the genus *Pandorina*, *Syncrypta*, or *Eudorina*, Ehr.

Volvox, examined in autumn and early winter, often exhibits either the green bodies with a thick coat (Pl. 7. fig. 33), or the inner globes are of an orange colour (Pl. 7. figs. 26 & 34), which appear to be successive stages of development of a *resting-spore*. When mature, this possesses at least two coats, one immediately surrounding the granular contents, another at some distance outside the former, transparent, colourless, and as it were glassy and brittle, breaking with sharp-angled cracks when pressed (Pl. 7. figs. 34 & 35). We cannot detect any intermediate substance or layer, which would be required to complete the analogy with the resting-spore of SPIROGYRA as described by Pringsheim (Pl. 9. fig. 21); perhaps it does not exist in either case. Sometimes the outer coat of the enclosed yellow globes is tuberculated or covered with conical elevations (Pl. 7. fig. 36). The form with the smooth yellow resting-spores (Pl. 7. figs. 26 & 34) represents Ehrenberg's *Volvox aureus*, and the form with the spines (Pl. 7. fig. 36) his *V. stellatus*. The development of the resting-spores of *Volvox* has been fully described by Cohn, and presents an essential resemblance to the process in PANDORINA and STEPHANOSPHÆRA. Some of the gonidia become enclosed in special cyst-like coats; and their contents are then converted into spermatozoids, which break out and move actively in the interior of the spherical common envelope. These bodies fertilize other gonidia, which take on the function of spore-cells; and after their impregnation the latter acquire the firm coats and yellow contents characteristic of the resting-spores. They are set free at first into the common cavity of the spherical envelope.

A doubt remains as to the nature of the object described as *Synura uvella*; it may belong here, or, not improbably, to the genus *Uvella* (Pl. 32. fig. 18), which itself may be no more than a complex form of PROTOCOCCUS or *Chlamidomonas* (Pl. 7. fig. 2; Pl. 23. fig. 30), which doubtless includes also *Chlorogonium* (Pl. 30. fig. 31), *Cryptoglena* (fig. 35), and *Gyges* (Pl. 50. fig. 14).

When a pool contains *Volvox*, the individuals are generally abundant, and may be readily seen by the naked eye, as pale-green globules, in a phial of water held up to the light; but they are kept with difficulty, being devoured by ROTATORIA, &c. The cilia are best seen by drying and wetting them again, or by applying iodine. The gonidia are a good deal altered by chloride of calcium.

BIBL. Ehr. *Inf.*; Pritchard, *Inf.*; Williamson, *Tr. Phil. Soc. Manchester*, vol. ix.; *Tr. Mic. Soc.* 2. i. 45; Busk, *ibid.* 31; Cohn, *Ann. Sc. Nat.* 4. v. 323; *Ann. N. H.* 2. xix. 187; Rabenh. *Alg.* iii. 26; Cooke, *Algæ*, 1882.

VORTICEL'LA, Linn.— A genus of Peritrichous Infusoria, of the family Vorticellina.

Char. Body campanulate, with an anterior ring of cilia, stalked; stalk simple, spirally contractile.

These interesting Infusoria are very commonly met with in decomposing vegetable infusions, as of hay, portions of dead flowers, &c. Their curious metamorphoses and modes of reproduction, are noticed under INFUSORIA.

V. nebulifera (Pl. 32. fig. 21). Body conico-campanulate, colourless; anterior margin dilated; body without rings when contracted. Length of body without the stalk 1-576 to 1-288″.

V. microstoma (Pl. 32. fig. 26, body with gemmæ). Body ovate, narrowed at the ends, greenish white; anterior margin not dilated, nor body ringed when contracted. Length of body 1-2000 to 1-250″.

V. convallaria. Body ovato-conical, whitish hyaline, annulate; expanded anterior margin slightly prominent. Length of body 1-430 to 1-240″.

Many other species.

Dujardin unites the genera *Carchesium* and *Zoothamnium* to his genus *Vorticella*.

Bibl. Ehr. *Inf.* 269; Duj. *Inf.* 546; Lachmann, *Ann. N. H.* 1857, xix.; Clap. et Lach. *Inf.*; Greef, *Ann. N. H.* 1872, 105, 196, 384, 462; Allman, *Mn. Mic. Jn.* xiv. 178; Kent, *Inf.* 667.

VORTICELLI'NA.—A family of Infusoria.

Table of Genera.

						Genus.
Vorticellina.	Without a posterior crown of cilia during the greater part of life.	Naked.	A peduncle.	Peduncle contractile.	Not branched	*Vorticella.*
					Branched. Each branch having a special muscle	*Carchesium.*
					Branched. A single branched muscle	*Zoothamnium.*
				Peduncle not contractile		*Epistylis.*
			No peduncle.	Posterior part of body attached by a disk.	A helical funnel in front	*Spirochona.*
					No funnel	*Scyphidia.*
				No disk		*Gerda.*
		Sheathed.	No true sheath, the peduncle lost in a gelatinous mass			*Ophrydium.*
			A sheath.	Animal fixed to the base of the sheath.	Sheath fixed by its base	*Cothurnia.*
					Sheath fixed by its side	*Vaginicola.*
				Animal suspended freely in the sheath		*Lagenophrys.*
	With a posterior ciliary crown during the whole of life; body free					*Trichodina.*

Bibl. Clap. & Lach. *Inf.* 93; Allman, *Qu. Mic. Jn.* 1872, 393.

VORTICLA'VA, Alder.—A genus of Hydroid Zoophytes.

Char. Polypes on simple stems, developed at intervals on a creeping filiform stolon; tentacles in two dissimilar whorls, the oral short and capitate, the outer longer and filiform; reproduction unknown.

Two species, on stones and corallines.

Bibl. Hincks, *Hydr. Zooph.* 131; Wright, *Qu. Mic. Jn.* iii. n. s. 50.

VULVULI'NA, D'Orb.—See Textularia.

W.

WART.—The common hard wart consists of a circular group of elongated papillæ with their free extremities slightly enlarged and bulbous, their vessels dilated and extending close up to the epithelial covering. This presents its normal threefold division, inasmuch as a thick layer of transition-cells fills up all the interstices between the enlarged papillæ, while the horny lamina invests the group of papillæ with a common covering. (Rindfleisch, *Path. Hist.*)

WASP. See Vespa.

WATER.—Under this head we might form a kind of index referring to a large proportion of the articles of which this volume is composed, since water, existing under different circumstances, forms one of the most fertile sources of microscopic objects; but as our space and plan do not admit of such an enumeration, we must be content to dwell shortly upon two of the most important questions in which the microscope is applied to the examination of the contents of water.

Ordinary examination of water.—Here it appears merely necessary to point out that the mode of examining the contents of samples of water, for the purpose of ascertaining the extent to which organic beings are contained in them, should be very different from that pursued by the microscopist who is engaged in collecting specimens. We make this remark in consequence of the gross misrepresentations which have been made respecting the "animalcules" in water, carried to their most absurd extreme in the so-called "drop" of water shown by oxyhydrogen microscopes, where we often see the field covered with larvæ of dragonflies, of beetles, of gnats, &c., Entomostraca, and worms of different kinds, not only preceptible without a microscope, but, in the case of the larvæ, perhaps really more than an inch long. Less violent exaggerations occur when water which appears cloudy is selected, allowed to stand for some

time, and the *sediment* examined. Very false results must also be obtained when water is exposed to the air for any length of time before examination, since Infusoria and microscopic Algæ always appear in a short time, even in distilled water, when exposed to the atmosphere; and an uncovered water-butt or cistern will be found a very fertile source of microscopic objects. We regard the presence of most of those organisms which do not sufficiently affect the water to render its impurity discernible by the naked eye, as a matter of little consequence. Large numbers of Entomostraca, certain Rotatoria and Infusoria, and Oscillatoriaceous Algæ, generally very perceptibly clouding or colouring the water, of course indicate the presence of much decomposing organic matter in the water, which, however, reveals itself very clearly in a short time when the water is kept, by a fetid odour. The presence of green Confervoid Algæ is by no means a sure sign of impurity properly so called, in water; for some will only grow in very clear and pure water, while many of them may be regarded as agents of purification. The presence of Zygnemaceæ, Diatomaceæ, and especially the Schizomycetes, is, however, particularly objectionable, as they become very fetid in decomposition, which generally takes place very soon when they are disturbed and injured. When large numbers of minute Algæ appear in water, discolouring it over extensive surfaces, the microscope will enable us to detect the nature of the object producing the appearance, but will scarcely be requisite to prove the impurity of the water.

The microscope is also of great importance in detecting the presence of undigested and bile-stained particles of food, showing the admixture of sewage with water.

Coloration of water. — Under this head we shall refer to those plants and animals which most commonly produce such appearances, premising that the commonest cases of coloration depend upon suspended mineral substances (mud), of different colours according to the soils washed by the water.

1. Producing a general *green* colour, or a thick film on the surface.—PROTOCOCCUS (*Chlamidomonas*, Ehr., *Diselmis*, Duj.), very common in the spring; and various Nostochaceous Algæ, as TRICHORMUS, CONIOPHYTUM, &c. (see NOSTOCHACEÆ; many with a bluish tinge); CLATHROCYSTIS (forming a granular verdigris-green layer), MICROHALOA, and various other PALMELLACEÆ and CONFERVACEÆ; EUGLENA *viridis*, &c. The DESMIDIACEÆ form greenish patches at the bottom of water or on plants, as do certain OSCILLATORIACEÆ.

2. Producing a *red* colour in fresh water. —ASTASIA *hæmatodes*, Ehr.; species of DAPHNIA. TUBIFEX produces a red colour on the mud in shallow water. Red forms of species of PROTOCOCCUS (see also RED SNOW).—In salt water, DISELMIS *Dunalii*, Duj.; TRICHODESMIUM.

3. A brown cloudy appearance often appears in masses near the source of small springs of water flowing out of blue clay, or in pools on peat-bogs. This mostly consists of peroxide of iron; but sometimes a similar brown appearance is produced in pools by collections of amorphous granular decaying organic matter, in which occur great abundance of certain OSCILLATORIÆ, DIATOMACEÆ, INFUSORIA, and ROTATORIA. The obscure mycelioid structure called by Kützing LEPTOTHRIX *ochracea* produces a yellowish-brown tint; DIDYMOHELIX also gives a brown colour to water. Diatomaceæ often form a yellowish-brown coat on mud at the bottom of water. Many Rotatoria and the larger Infusoria (PARAMECIA, &c.), when abundant give water a slightly milky appearance.

The ordinary method of separating the organic bodies from water, is to place it in a conical glass, and allow them to subside. A little spirit or osmic acid should be previously added to prevent growth or reproduction. The bodies are then removed with a pipette, or separated by filtration through Swedish paper.

The above list is undoubtedly very imperfect, but may afford some useful hints. Microscopists who meet with such colorations will naturally examine them carefully; they will find further information under the heads of the articles cited.

BIBL. Macdonald, *Soc. Sci. Congress*, 1877; Scott, *Jn. Mic. Soc.* 1877, *Mn. M. Jn.* xviii. 237; Church, *Water*, 1877; Fox, *Food &c.* 1881; Cohn, *Beitr. z. Biol.* i. 108; Blyth, *Food &c.* 1881; Frankland, *Water-Analysis*.

WATER-BEARS. See TARDIGRADA.

WEBBI'NA, D'Orb. (Restricted.)—A subgenus of *Trochammina*; adherent, single-celled, moniliform, or alternating. Recent and fossil.

BIBL. Parker and Jones, *Phil. Tr.* clv. 435; P., J., & Brady, *Monog. Crag For.* 25.

WEISSIA, Hedwig.—A genus of Pot-

tiaceous Mosses, variously defined by authors, related to *Gymnostomum*. *W. controversa* (*W. viridula*, Müll.) is common on banks. Wilson includes *Blindia* here, and separates *W. fugax* and *denticulata* as *Rhabdoweissia*. (Wilson, *Bryol. Br.* 46.)

WESTWOODIA, Dana, = *Arpacticus* pt. *W. nobilis* = *Arp. nob.*; marine. (Brady, *Copep.* ii. 140.)

WHALEBONE.—In whales the teeth are rudimentary; and arising from a depression in the upper jaw on each side are a number of parallel horny plates, many feet in length, which project downwards: these plates, which are technically known as fins or blades, constitute whalebone; and through them the water containing the animals upon which the whale lives is strained, and the food thus obtained. These plates are situated upon a vascular membrane, folds of which enter a cavity at their base, which is the portion connected with the jaw.

Whalebone may be pretty easily divided into longitudinal laminæ and fibres; but these are only secondary forms resulting from the aggregation of a number of cells of which whalebone wholly consists.

On examining a transverse section of a blade or plate of whalebone with the naked eye, or a lens, two structures are readily distinguishable—an inner porous-looking medullary portion, surrounded by an outer compact or cortical substance. A longitudinal section through the plate exhibits a number of dark lines or stripes, from about 1-100 to 1-150″ in diameter, parallel to each other and to the axis of the plate, and corresponding to the pores seen in the transverse section. These stripes, which have been called whalebone-canals, but which we shall denominate medullary lines, are seen to be surrounded by a paler substance.

With a higher power (¼ inch), the transverse section exhibits in the centre a number of rounded apertures or circles corresponding to the pores (Pl. 22. fig. 31), surrounded by very fine, concentric, interrupted dark lines, whilst towards the circumference these lines run parallel to the surface of the plate. In the longitudinal section, viewed with this power, the medullary lines are seen to consist of a number of cells (Pl. 22. fig. 30), mostly arranged in single longitudinal series, and, in dried whalebone, having a very dark appearance by transmitted light, from the presence within them of a large quantity of pigment and air. These are the medullary cells. The substance between the lines of medullary cells exhibits very fine longitudinal striæ, and, in parts, the ends of divided laminæ.

On macerating whalebone for twenty-four hours in solution of caustic potash, it becomes soft; and on afterwards digesting it in water, the cortical portion resolves itself into numerous large transparent cells from 1-230 to 1-310″ in length, and from 1-500 to 1-330″ in breadth (Pl. 22. fig. 33). These contain a variable number of granules of pigment, of a deep brown colour, also some small globules of fat, which are especially numerous in those portions nearest the base of the plate. These cells in the natural whalebone are laterally compressed or flattened; and the transverse axes of those surrounding the medullary lines are arranged tangentially to the latter, whilst in the cortical portions these axes are parallel to the surface of the plate. The concentric lines seen in a transverse section arise principally from the pigment-granules within those cells which surround the medullary cells becoming arranged in a linear series by the flattening of the cells enclosing them. This may be shown by treating a transverse section of whalebone with caustic potash, and then adding water and watching its resolution into cells. As these expand, the interrupted lines are seen also to expand as it were, and to become resolved into a number of distinct pigment-granules existing within each cell. The lines seen in a longitudinal section arise from the unequal refraction of light by the laminæ of compressed cells surrounding the medullary lines.

The medullary cells contain a large quantity of pigment, as do also those compressed cells which immediately surround them; in the former these granules are frequently aggregated. In the common dry whalebone of commerce the medullary cells also contain air, which has been mistaken for fat, and hence the cells denominated fat-cells. The air is readily displaced by liquids. Between the compressed cells, minute cavities containing air, sometimes assuming a linear form, at others representing mere dots, are seen both in the transverse and longitudinal sections; these are distinguished by the displacement of their contents. Hence ordinary whalebone closely resembles hair or horn in its structure; and the fibres which are seen projecting from the margin of the blades as found in commerce have a remarkable similarity to hair

(Pl. 22. fig. 32). Chemically, it consists of a proteine compound, and is therefore coloured by Millon's and Pettenkofer's test-liquids.

Whalebone polarises light like horn.

Bibl. Hunter, *Phil. Trans.* 1787; Donders, *Mulder's Phys. Chemie*; Lehmann, *Phys. Chem.*

WHEAT.—The starch of the grain of wheat (*Triticum vulgare* and other species and varieties) presents itself in the form of delicate little flattish lenticular bodies, very characteristic (Pl. 46. fig. 8). Wheat is subject to various Blights, which are referred to under that head, depending on the growth of parasitic Fungi, especially Tilletia, attacking the ear, Puccinia attacking the straw, &c. In other cases the ear is found infested with a minute worm (Anguillula *tritici*) remarkable for its tenacity of life.

WINGS of Insects.—The arrangement of the veins or nerves of the anterior wings of the Hymenoptera is sometimes used to form the basis of systematic arrangement; and the several veins and interspaces have received distinct names, which may be illustrated by reference to Pl. 34. fig. 11, representing the anterior wing of the humble-bee (*Bombus terrestris*): *a*, costal nerve; *b*, hind margin; *c*, inner margin of wing, with the fold (*k*) for the attachment of the hooks; *d*, postcostal nerve; *e*, externo-median; *f*, anal; the nerve between 3 and 10, the transverso-median; *h*, anterior or outer margin; *l*, the subdiscoidal; *s*, stigma; 1, costal cell; 2, externo-median cell; 3, interno-median; 4, anal; 5, radial or marginal; 6, first cubital cell; *m*, *m*, *m*, second, third, and fourth cubital cells; 10, first discoidal cell; 11, second ditto; 12, third ditto; 13, first, and 14, second apical cell.

See Insects, *wings*.

Bibl. That of Insects; Jurine, *Nouvelle Méthode*; Shuckard, *Tr. Entom. Soc.* i.; Staveley, Miss, *Neuration*, *Linn. Trans.* xxiii. 125; Semper, *Siebold & Kölliker's Zeitschr.* viii. 326.

WINTEREÆ.—A section of the Dicotyledonous family Magnoliaceæ (Drimys, *Tasmannia*), remarkable for the character of the elementary structure of the wood, approaching closely to that of the Coniferæ. It consists, as in that family, wholly of pitted prosenchymatous cells without ducts, the cells having two or three rows of bordered pits as in Araucaria. A distinction exists, however, in the character of the medullary rays, which are very numerous in Wintereæ, occurring both large and small, six or seven in the breadth of 1-12″ in a vertical section at right angles to the rays—some of them being thin, composed of one or two parallel layers of cells, extending to a vertical extent of about ten cells, others much larger, ten or twelve cells thick (or broad), and of a vertical extent of eighty or a hundred cells; the latter are very evident on the surface of the wood when the bark is removed. The medullary rays here traverse all the annual layers of wood, which is not the case in the Coniferæ.

Bibl. Goeppert, *Linnæa*, xvi. 135 (1842); *Ann. Sc. Nat.* 2. xviii. 317.

WOOD.—The mode of origin of wood is explained in the articles Cambium, Medulla, Medullary Rays, and Vascular bundles, while the characters of the elementary organs of which wood is composed are described under the heads of Cell: Fibrous, Pitted, and Spiral Structures; and Secondary Deposits. Peculiar composition of the wood in certain classes, families, or genera of plants is also noticed under their special heads, which will be referred to presently. In this article the principal modifications of the wood, as a whole, occurring in these and certain other cases, are to some extent classified, in order to indicate their relations, and to furnish a guide to microscopists seeking to observe the most remarkable varieties of structure, occurring in this substance.

The elements entering into the composition of wood are :—1, Fibro-vascular bundles, which in their most complete form contain Spiral and other Vessels, Pitted ducts, Prosenchymatous cellular tissue with thickened walls (*woody fibre*); and in the Monocotyledons, *vasa propria*, as they are called by Mohl, viz. elongated tubular cells of membranous structure occurring in the centre of the bundles. 2, Medullary Rays in the Dicotyledons, or a generally diffused medullary parenchyma in the Monocotyledons. 3, Woody parenchyma, which is found under different conditions and in different quantities in different cases.

The Gymnosperms may be considered in the above enumeration as agreeing with the Dicotyledons. The less-generally diffused structures connected with Secretion are here left out of view.

In classifying the kinds of wood, we may commence with the less perfect forms.

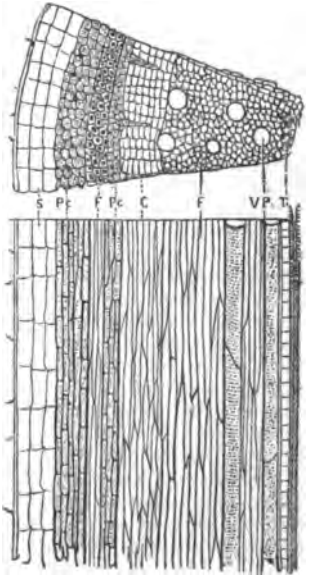
Monocotyledons.—In our native plants of this class the stem is mostly herbaceous, and the woody structure then occurs simply in the form of "fibres" (*fibro-vascular bundles*, fig. 456, p. 495), the structure of which has been described elsewhere (fig. 791, p. 800). The same kinds of elements are arranged in nearly the same way in most of the arborescent plants of this class, such as Palms—for example, in the Cocoa-nut Palm, in the common Cane (*Calamus*), or the various striped solid canes (all Palms) used for walking-sticks, &c. The solid woody texture depends in these upon the interspace between the fibro-vascular bundles being filled up with *woody parenchyma*; *i.e.* the general medullary substance, which in such stems as that of the White Lily is soft and spongy, in the Palms &c. becomes solidified by the great deposition of secondary layers upon the walls of the cells; thus the bundles, at first "fibres," are bound together into a solid *wood*. The thick woody walls of the hollow Bamboo cane are constructed on the same plan, being highly developed and lignified forms of the structure which is exhibited in a soft and herbaceous condition in our common Grasses.

Certain Monocotyledons present a structure which differs from the above in the appearance presented by transverse sections. In the Smilaceæ, and some of the Dioscoreaceæ, the fibro-vascular bundles are arranged in more definite order in one or two circles; but there is no distinction of pith, medullary rays, and bark here; the bundles are bound together by *woody parenchyma*, and there is no cambium-region beneath the rind. The anomalous growth exhibited by the stems of other Monocotyledons, such as *Dracæna*, *Yucca*, &c., cannot be regarded as depending on the formation of *wood* in the proper sense; in them, layers of fibrous structure are formed between the central region of the stem (containing the original vascular bundles) and the rind, which take their origin from the ends of the vascular bundles at the periphery of the stem beneath the rind, and extend down in a kind of false cambium layer beneath the rind.

Interesting objects illustrating the above structures are furnished by longitudinal and transverse sections of the trunks of large Palms and of the large woody leaf-stalks of these, of canes of different kinds, of Bamboo canes, the rhizome of Sarsaparilla plants (*Smilax*), *Ruscus*, the harder parts of the stem often found attached to imported Pine-apples, &c. Sections of silicified fossil Palm-stems, prepared by the lapidary, can also be obtained from the dealers in objects.

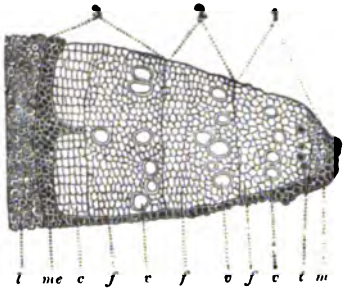
Dicotyledons.—In this class we meet with a remarkable diversity in the character of the wood, which moreover here exhibits, from the indefinite power of growth of the FIBRO-VASCULAR BUNDLES, a much more extensive and perfect development than in the Monocotyledons. In the articles MEDULLA (fig. 455, p. 495), MEDULLARY RAYS (fig. 457, p. 496), and VASCULAR BUNDLES (fig. 792, p. 801) are described the conditions of ordinary Dicotyledonous stems in the first year of their growth; it is stated in the account of the vascular bundles, that a new layer of wood is developed in the cambium layer in each succeeding season (fig. 457, p. 496). The nature of the elementary structures in such cases is illustrated by the accompanying figures from the Maple (*Acer campestre*, figs. 807 & 808),

Fig. 807.



Transverse and vertical section of a segment of a shoot of the Maple in the early part of the second year of its age. T, spiral vessels; VP, pitted ducts; F, woody fibre; C, cambium; Pc, cortical parenchyma; F, liber fibres; Pc, cellular envelope of the bark; S, corky layer of ditto. Magnified 60 diameters.

Fig. 808.



Transverse section of Maple-wood three years old. The figures 1, 2, 3 indicate the annual rings of wood; the rest is bark. *m*, medulla; *t*, spiral vessels; *v*, ducts; *f*, woody fibre; *c*, cambium; *me*, medullary parenchyma; *l*, liber. Magnified 40 diameters.

of which the former represents sections of a shoot at the begining of its second year, when the cambium layer (c) is swelling, the latter a shoot of three years' growth, the portions belonging to each year being indicated by the figures. The only difference between the structures developed in each succeeding season is the absence of a layer of spiral vessels (*medullary sheath*, in the first year) at the point where each year's growth commences. Here, as is seen, the body of the wood is composed chiefly of prosenchymatous cells (wood-cells or woody fibre, *f*), with a few pitted ducts (*v*) near the commencement of each annual layer; the medullary rays are narrow in this wood. In the Hornbeam (*Carpinus Betulus*) the wood is of very similar composition; the wood-cells, however, are more thickened, and the ducts exhibit a spiral marking; the annual layers are not very clearly defined in sections under the microscope. This is the case, again, with the excessively hard wood of the Box (*Buxus sempervirens*), which is of analogous composition. The Birch (*Betula alba*) has the same structure. Other common timber-trees exhibit an additional structure in their wood, namely masses of *woody parenchyma* interspersed in various ways among the ordinary prosenchymatous structure of the wood. A very small quantity of this occurs in scattered groups in the common Oak (*Quercus pedunculata*); here also the ducts are very large, appearing as open holes to the naked eye in cross sections; the larger medullary rays are likewise very evident. In the Beech (*Fagus sylvatica*) there is a small quantity of woody parenchyma, but greatly thickened prosenchyma prevails; the ducts are rather small; but the broader medullary rays are very evident, appearing to the naked eye as brown streaks in longitudinal sections. The Chestnut (*Castanea vesca*) differs from this chiefly in wanting the broader medullary rays. In the Elm (*Ulmus campestris*) the prosenchyma is interposed between bands of woody parenchyma and wide ducts, which renders the distinction of the annual layers obscure. The Walnut-tree has no woody parenchyma; the Apple- and Pear-trees have alternate bands of prosenchyma and woody parenchyma; these exist, but are narrower, in the Plum and Cherry. In the wood of most of the Leguminosæ (*Robinia*, *Ulex*, *Genista*, *Gleditschia*, &c.) the woody parenchyma appears in bands of considerable size; but the walls of its cells are less thickened than those of the prosenchymatous cells. Woody parenchyma occurs extensively in Mahogany and Rose-wood, producing a peculiar variation of colour in the wood; the large holes are the orifices of the very wide ducts.

The wood of the Poplars (*Populus*), and Willows (*Salix*), has the prosenchymatous cells little thickened. The Hazel (*Corylus Avellana*), and the Alder (*Alnus glutinosa*), present a peculiarity: the wood appears to the naked eye to have broad medullary rays: but under the microscope these rays are found to be portions of the wood devoid of ducts, intervening between segments with closely-pitted ducts placed at particular points in the annual rings. The Lime (*Tilia*) and the Horse-chestnut (*Æsculus*) have wood of soft texture, the prosenchymatous cells being only slightly thickened, while the ducts are large and numerous (these exhibit a spiral band, very evident in the Lime). The wood of the Plane (*Platanus occidentalis*) has strongly marked medullary rays; the prosenchymatous cells are greatly thickened; and mingled with them are very numerous ducts, and a small quantity of woody parenchyma. The stem of the Vine (*Vitis vinifera*) has likewise long and broad medullary rays; the wood is composed of prosenchymatous cells, with a spiral-fibrous deposit on their walls, while the cells of the woody parenchyma are devoid of this; the ducts are very long, and exhibit every gradation of form, from spiral, reticulated, and scalariform to pitted ducts. The various species of *Clematis* have strongly marked medullary rays, and wood chiefly

composed of pitted ducts, as is the case also in the common Rose.

In many of the above trees, the wood acquires a special peculiarity when it attains a certain age; the prosenchymatous cells generally become more solid, year by year, through the filling-up of their cavities by the increasing thickness of the secondary deposits on their walls: in the lighter-coloured and softer woods, such as the Lime, there is no distinct line of demarcation between the older and younger part of the trunk—the *alburnum* or *sap-wood* and the *duramen* or *heart-wood*; but in many cases, as in the Ebony (*Diospyros*), Lignum vitæ (*Guaiacum*), to a less extent in the Elm, Oak, &c., the *duramen* assumes a remarkable solidity and a deeper colour, so that after a certain time the colours of the *duramen* and *alburnum* are very different. This appears to arise from a chemical alteration of the substance of the secondary deposits of the prosenchymatous cells.

A great degree of regularity and agreement of structure exists between the woods of the Dicotyledons above mentioned. It remains to direct attention to various kinds which depart more or less from the type thus selected.

In the various parasitical Dicotyledons, such as *Lathræa*, *Melampyrum*, *Cuscuta*, &c., there is no layer of spiral vessels corresponding with the medullary sheath; and in the Mistletoe (*Viscum*) only annular ducts occur in this situation; the wood in the latter is largely composed of woody parenchyma, the cells of which are punctated, or possess spiral-fibrous layers (figs. 665, 666, page 712). The stem of *Myzodendron* also exhibits some remarkable anomalies.

In the Bombaceæ (*Bombax*, *Carolinea*, &c.) the mass of structure corresponding to the wood is chiefly composed of membranous parenchymatous cells, with scattered isolated prosenchymatous cells, and large pitted ducts. The wood of *Avicennia* is principally composed of large pitted ducts, with narrow interspaces filled up with small pitted parenchymatous cells.

The wood of the Cactaceæ (*Mammillaria*, *Melocactus*) is composed of dotted ducts, together with a kind of cell, apparently referable to parenchyma, the walls of which have a remarkably broad spiral-fibrous band (Pl. 48. fig. 7). The wood of the *Casuarinæ* exhibits a curious structure: it is composed of long prosenchymatous cells, the walls of which, together with those of the numerous large ducts, have bordered pits (Pl. 48. fig. 2); while concentric lines of cellular tissue appear at intervals in the cross section, consisting of plates of parenchyma extending from one medullary ray to the next, and connecting them. The stems of some of the Menispermaceæ have likewise concentric processes of parenchymatous tissue. In the Winterææ, a section of the Magnoliaceæ, the wood is wholly composed (with the exception of the medullary sheath) of pitted prosenchymatous cells resembling those of *Araucaria* (Pl. 48. fig. 5), without any ducts.

In certain families of Dicotyledons a remarkable appearance arises from the arrangement of the bundles in several circles, almost as in the Monocotyledons; but this results in a very different kind of structure, on account of the unlimited growth of the cambium in Dicotyledons. Examples of this kind of wood occur in the Chenopodiaceæ, Nyctaginaceæ, Piperaceæ, &c. In *Pisonia*, which has been supposed to grow in the same way, the result is a solid mass of wood, composed of prosenchymatous cells and ducts, with isolated perpendicular cords of parenchyma (exactly the reverse of what occurs in the Monocotyledonous stems). The woods of *Phytocrene* and *Nepenthes* may be further cited as offering remarkable peculiarities.

It would exceed the space which we can allow to this article to enter into a description of the anomalous Dicotyledonous stems of the tropical *lianes* or climbing trees, of the *Bignoniaceæ*, *Menispermaceæ*, *Malpighiaceæ*, &c.; the irregularities of the wood of which depend upon deviations from the normal type arising in the course of the growth of the stems, which, from the observations of Treviranus, Crüger, and others, appears to be mostly regular when quite young. Isolation of one or more fibro-vascular bundles from the central cylinder of wood, producing distinct centres of development, is the most common cause of irregularity.

The wood of Dicotyledons must be examined by transverse sections, and perpendicular sections parallel with and at right angles to the medullary rays. The same applies to the wood of Gymnosperms. The mode of cutting these sections is stated elsewhere.

Sections of recent woods are best preserved wet in chloride of calcium. Fossil wood, if silicified, is cut by the lapidary's

wheel; wood in the state of coal in like manner (see PREPARATION, FOSSIL WOOD, and COAL).

Gymnosperms.—In this division of the Flowering Plants we also meet with two types of structure:

Coniferæ.—Here the character of the wood agrees in general with that of the typical Dicotyledons, with certain distinctions; namely, although the medullary sheath of spiral vessels exists, no ducts or vessels occur in the mass of wood external to this, which is wholly composed of prosenchymatous cells, with bordered pits, in single (Plate 48. fig. 4) (usually), double, or treble (*Araucaria*) rows (fig. 5); in *Taxus* accompanied in part by a spiral-fibrous band (fig. 4). The particulars of these forms are given under CONIFERÆ. It may be mentioned that the "woody parenchyma" of Dicotyledons seems to be represented here by the cords of parenchymatous cells in some cases traversing the prosenchyma, ultimately filled with resinous deposits ("cords of secretion-cells").

Cycadaceæ.—The earliest condition of the stems here appears to resemble that in Coniferæ; but no annular rings are formed. Concentric layers are produced at intervals, however, separated by parenchymatous layers. The true mode of origin of these does not appear to be clearly made out. The wood is composed of pitted prosenchymatous cells (Pl. 48. fig. 20), without vessels or ducts, excepting in the medullary sheath of spiral vessels.

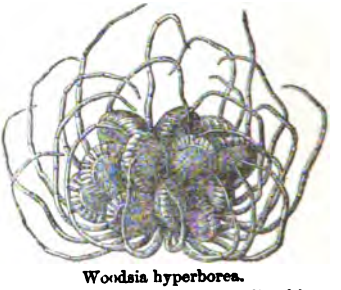
Some elaborate and interesting researches on the peculiar intimate structure of wood and tissues have been published by Harting, Sanio, Nägeli, and Hanstein; but we have no space to analyze these long papers here.

For further details on the markings of the ducts, &c., see PITTED and SPIRAL STRUCTURES.

BIBL. Lindley, *Intr. to Bot.*; DeCandolle, *Organographie*, i. 161; Meyen, *Pflanzenphys.* i. 331; Goeppert, *Struct. Conifer.* 1841, *Linnæa*, xvi., xvii., *Ann. Sc. Nat.* 2. xviii. 1 & 317; Brongn. *Végét. Fossiles*, 1828, *et seq.*, *Ann. Sc. N.* 1. xvi. 589; Hooker, *Flor. Antarct.*, *Ann. Sc. Nat.* 3. v. 193; Gaudichaud, *Recherches Anat.*, and *Ann. Sc. Nat.* 3. passim; Meneghini, *Ricerche sulla Struttura Monoc.*; Schacht, *Pflanzenzelle*, 193, *Das Baum*, 94; Crüger, *Bot. Zeit.* viii. 99, x. 465; Trécul, *Ann. Sc. Nat.* 3. xviii., xix., xx., 4. i., ii., iii.; Milde, *Beitr. z. Bot.* 1850; Hanstein, Pringsheim's *Jahrb.* i. 232; Sanio, *Linnæa*, 1858; Hartig, *Bot. Zeitung*, xvii.; Henfrey-Masters, *Bot.*; Sachs, *Bot.*; Kny, *Holzkörper*, 1882.

WOOD'SIA, Brown.—A genus of Dicksonieæ (Polypodiaceous Ferns), represented by two rare indigenous species, *W. Ilvensis* and *hyperborea*. Sori globose; indusium inferior, cup-shaped or globose, sometimes enclosing the sorus, opening at the top, the mouth or margin irregular, lobed or fringed with long hairs (fig. 809). Several tropical species. (Hooker, *Syn.* 46.)

Fig. 809.



Woodsia hyperborea.
A sorus and indusium with a hair-like fringe.
Magnified 50 diameters.

WOODWAR'DIA, Smith.—A genus of Blechneæ (Polypodiaceous Ferns). Several species; exotic.

Fig. 810.

Woodwardia.
A fertile pinnule. Magnified 5 diameters.

WOOL OF ANIMALS. See HAIR. The fibres of wool are coloured by the test-liquids of Millon and Schultze.

WRANGE'LIA, Ag.—A genus of Ceramiaceæ (Florideous Algæ), differing from *Griffithsia* chiefly in the scattered tetraspores. *W. multifida*, the only British species, has rose-red feathery fronds, an inch high, consisting of a main filament, about as thick as a bristle, composed of a single row of cells, bearing long, pinnately-arranged, patent branches, mostly branching in the same way again. At the articulations occur two opposite (or more rarely a whorl of) pinnato-multifid or subdichotomous ramelli 1-12 to 1-6″ long. The fructification consists of:—1, *favellæ*, borne on stalks at the joints, and surrounded by a whorl of ramelli; and 2, elliptical *tetraspores*, opposite, secund or tufted, on the lower part of the ramelli. In some foreign species *antheridia* have been observed in similar situations to the tetraspores.

BIBL. Harvey, *Mar. Alg.* 169, pl. 24 D; *Phyc. Brit.* pl. 27; Derbès and Solier, *Ann. Sc. Nat.* 3. xiv. 273, pl. 35; Thuret, *ibid.* 4. iii. 38.

X.

XANTHID'IA.—The bodies found in flint, and thus called, are probably sporangia of Desmidiaceæ (Pl. 25. figs. 22-28). They have been distributed in genera and species, the description of the characters of which would be useless.

It is a curious circumstance, that these sporangia should be found in flint, which is of marine origin, considering that the Desmidiaceæ are none of them marine.

XANTHID'IUM, Ehr.—A genus of Desmidiaceæ.

Char. Cells single, constricted in the middle; segments compressed, entire, spinous, with a circular, usually tuberculated projection near the centre. Spines more than two to each segment.

X. armatum (Pl. 14. fig. 23; fig. 24, empty cell, showing the projections). Segments broadest at the base; spines short, stout, tri- or multi-fid; length 1-180″.

X. fasciculatum (Pl. 14. fig. 25). Segments with from four to six pairs of subulate marginal spines; central projections minute, conical, and not beaded; common; length 1-400″.

Sixteen species.

BIBL. Ralfs, *Br. Desmid.* 111; Rabenht. *Alg.* iii. 221; Archer, *Pritchard's Infus.*

XANTHIOPYX'IS, Ehr.—A genus of fossil Diatomaceæ, consolidated with PYXIDICULA. It consisted of those species the margins of the valves of which are furnished with a dentate membrane, or the surface covered with setæ or hair-like processes. Bermuda.

BIBL. Ehr. *Ber. Berl. Akad.* 1844, 264; Kütz. *Sp. Alg.* 23; Pritchard, *Infus.* 826.

XENOD'OCHUS, Schlecht.—A genus of Uredinei (Hypodermous Fungi), consisting of black tufts, found on the leaves of *Poterium*, containing microscopic, short, curved, usually shortly stipitate filaments, attenuated at each end, composed of a moniliform row of (five to fifteen) globose cells filled with black granules.

These bodies occur associated with *Uredo miniata*, of which *X. carbonarius* appears to be the perfect form. *Xenodochus* is only distinguished from PHRAGMIDIUM by the greater number of joints.

BIBL. Schlechtendahl, *Linnæa*, i. 237, pl. 3. fig. 3; Fries, *Sum. Veg.* 505; Berkeley, *Ann. N. H.* i. 263.

XENOSPHÆ'RIA, Trevis.—A genus of Micro-lichens, parasitic on the thallus of *Solorina saccata*.

Char. Spores 6-8, oblong, 4-6-locular, brown; sometimes large, irregular, and muriform.

BIBL. Körber, *Syst.* 326; Lindsay, *Qu. Mic. Jn.* 1869, 344.

XESTOLEBE'RIS, Sars.—One of the *Cytheridæ*, with subtriangular valves, higher behind than in front, smooth, with distant papillæ; lower antennæ with 4 joints; upper 6-jointed, with simple setæ, and short. Two living British species, common.

BIBL. Brady, *Tr. Linn. Soc.* xxvi. 437.

XIPHIAS'TER, Murray.—A genus of Ixodea (Acarina). Flat, with a long projecting rostrum and long applied palpi; abdomen beaded behind. *X. rostratum*, Old Calabar. (Murray, *Ec. Entom.* 201, fig.)

XIPHICHI'LUS, Brady.—One of the *Cytheridæ*, near *Paradoxostoma*; with subequal, compressed valves, elongate, pointed, thin, and smooth. Two living British species, rare. (Brady, *Nat. Hist. Tr. North. & Durh.* iii. 369).

XYLA'RIA, Schrank.—A genus of Sphæriacei (Ascomycetous Fungi), several of which are common on rotten wood, stumps

of trees, &c. They are branched, horny or fleshy bodies, with often clavate lobes, whitish and mealy when young, afterwards brown or black, with black, horny, immersed perithecia all over the branches, or with the tips barren; the perithecia have a black centre composed of asci, each containing eight (usually uniseptate) spores.

Bibl. Berk. *Br. Fl.* ii. pt. 2. 234; Fries, *Sum. Veget.* 381.

XY'LEM.—Nägeli's name for the woody tissue forming part of the fibro-vascular bundles of stems. It is composed of spiral vessels, woody fibres, pitted ducts, and wood-parenchyma.

XYLOG'RAPHA, Fr.—A genus of Graphidei, Lichenaceous Lichens.

Char. Apothecia black, linear, plane, internally ashy; spores 8, simple. 4 sp., rare. (Leighton, *Lich. Flora*, 390.)

Y.

YEAST(-PLANT). — This well-known substance, which possesses the remarkable property of resolving sugar in solution into alcohol and carbonic acid, consists of a minute fungus, or rather of a particular condition of development of a certain fungus.

When yeast from an actively fermenting liquid is examined with the microscope, it is seen to consist of myriads of minute cells or vesicles, about 1-3000 to 1-2400" (Pl. 26. fig. 23) in diameter, containing a nucleus and some granules. During the progress of the fermentation, these cells increase in number, by budding, until either the sugar or the nitrogenous matter of the fermenting liquid is exhausted, when the cells, especially those nearest the surface, become elongated, remaining connected end to end, until they reach the surface, where they produce their fructification.

The growth of the yeast-plant has been carefully studied by several observers. We may describe some observations of our own, which confirm those of Mitscherlich and others. Some fresh wort, in which fermentation had commenced, was obtained from a brewery, and a drop of the liquid, containing yeast-globules, placed upon a slide and covered with a piece of thin glass. After the removal of the extraneous liquid, the upper glass plate was cemented to the lower one; the slide was then placed under the microscope, with the 1-4th object-glass and the micrometer eye-piece, in such a manner that several well-formed globules were visible; and these were drawn on ruled paper.

At first the globules or cells enlarged until they had attained a certain size; then there elapsed a short interval, during which no change was observable. Next there took place a projection of some point of the cell-wall, which first appeared as a little point-like bud, afterwards becoming larger and larger, until at last a new cell, of the size of the parent cell, was formed. Within three hours a cell was so far developed that a new one was formed from it, and thus an independent individual perfectly developed. The rapidity of growth probably varies with the temperature and the nature of the process: in twenty-four hours, when the thermometer was at about 78° in the day, sixteen cells were developed from one. After a time the growth slackened; finally no further increase took place, undoubtedly because all was removed from the liquid which could serve for their growth. Growing globules from this experiment are figured in Pl. 26. fig. 23.

Berkeley and Hoffman went a step further, by contriving to get an atmosphere of air round the drop of sugar and water, and saw the cells of the yeast-fungus as soon as it reached the air developed into a *Penicillium*.

By the observations of numerous competent investigators, it seems certain that the fermentation of beer, of wine, and in fact all vinous fermentation, is effected by the growth of this plant; and after the evidence brought forward in the articles Fermentation, Torula, and Vinegar-plant, there is little doubt that the Vinegar-plant, the *Oidium lactis*, and other supposed distinct plants are but forms of the Yeast-plant. Pl. 26. fig. 24 exhibits the condition of the Yeast-plant on the surface of exhausted wort of malt, before the Vinegar-fungus appears; fig. 756, page 773, the *Torula*-form at the margins of the surface of liquids.

We cannot clearly make out any difference between the 'top yeast' and 'bottom yeast' (*Oberhefe* and *Unterhefe* of the Germans), beyond the difference resulting from more or less active development: when the growth is rapid the cells are more spherical and become quickly detached, and the evolution of gas comes up more to the surface; when the yeast vegetates quietly at the bottom of the liquid, its cells are more elongated. We do not believe the yeast-cells ever burst to discharge reproductive granules. The globular form is known by various names, as *Mycoderma cerevisiæ*,

Desm., which agrees with *Cryptococcus glutinis*, Kütz.; the globular form in the Vinegar-plant is Kützing's *Ulvina aceti*; the filamentous form with simple moniliform fruit (fig. 756) is *Torula cerevisiæ*, Turpin; without fruit, species of *Hygrocrocis* or *Leptomitus*, the final form being apparently *Penicillium glaucum* (Pl. 26. fig. 15).

The Yeast-plant is truly most ubiquitous; but so are the conditions for its growth, while its reproductive power is enormous, and its small size renders it liable to be scattered by imperceptible movements of the air. *Aspergillus glaucus* is almost as constant in its favourite nidus, cheese; *Mucor mucedo* on paste, &c.; *Botrytis vulgaris* on dead leaves and stems in damp places, &c.: and all these are certainly not pseudomorphic productions; and if, as we believe really to be the case, yeast is but the *conidial* form of *Penicillium glaucum*, there has been no lack of the spores of the latter in the air, in any situation where we have ever exposed vegetable substances for any length of time to a damp atmosphere.

Rees has lately observed in yeast, which he calls *Saccharomyces*, that when sown on plaster of Paris, or some convenient substance, certain cells at length swell and contain sporidia. But after the fact that sporidia are developed within the threads of *Chionyphe* and in *Hemileia*, this does not seem of much consequence.

The Yeast-fungus is often developed in ripe grapes, causing vinous fermentation. In an article published in Ann. d. Sc. Nat. the globules are regarded by Karsten as merely pathological; but this is contradicted by the facts above mentioned.

Bibl. Turpin, *Mém. de l'Institut*, xvii. 93; Lowe, *Tr. Edinb. Bot. Soc.* 1857; Bail, *Flora*, 1857, 417; Berkeley, *Crypt. Bot.* 242, 299; Karsten, *Ann. N. H.* 4. xiii. 161; Rees, *Alkoholgährungspilze*, 1870; Sachs, *Bot.* 254; and the *Bibl.* of Fermentation.

YEW. See Taxus.

Z.

ZA'MIA, Lindl. See Cycadaceæ.

ZAN'CLEA, Gegenbaur.—A genus of Corynidæ, Hydroid Zoophytes.

Char. Stem simple or branched, rooted by a creeping filiform stolon; polypes more or less clavate. Tentacles capitate, scattered over the body; gonophores borne on the body of the polype and producing free medusiform gemmæ.

Z. implexa, marine, on shells, stones, &c.

Bibl. Gegenbaur, *Versuch eines Syst. d. Medusen*, *Zeit. f. wiss. Zool.* 1856, 229; Hincks, *Hyd. Zooph.* 58.

ZAUS, Goodsir.—A genus of Copepodous Entomostraca. Two species, marine. (Brady, *Copep.* ii. 153.)

ZETES, Koch.—A genus of Arachnida, of the order Acarina and family Oribatea. It is consolidated with *Galumna*.

ZINC.—The crystals of the *lactate*, as deposited from an aqueous solution, are represented in Pl. 11. fig. 20; they belong to the right-rhombic prismatic system.

The *chloride of zinc* is useful as a preservative of animal tissues. (See Preservation.)

Chloriodide of zinc. See Schulze's Test.

Bibl. That of Chemistry.

ZOËA.—The larval stage of some of the higher Crustacea.

ZONARIA, Harvey (*Aglaozonia*, Zanard, Kütz.).—A genus of Dictyotaceæ (Fucoid Algæ), of which the British species, *Z. parvula*, forms olive-green, membranous, fan-shaped fronds, 1″ or more in diameter, growing over stones or corallines, to which it attaches itself by whitish fibres on the lower surface. It is scarcely marked with concentric lines like Padina. The fructification occurs in scattered sori on both surfaces, and is apparently analogous to that of Padina, but requires further examination, since Thuret has shown that the true Dictyotaceæ have peculiar reproductive organs, spores, tetraspores, and antheridia, so that they stand between the Fucaceæ and the Florideæ.

Bibl. Harvey, *Mar. Alg.* 38, pl. 6 D; Thuret, *Ann. Sc. Nat.* 4. iii. 25.

ZONOTRIC'HIA, Ag.=Ainactis and Euactis. (Rabenht. *Alg.* ii. 212.)

ZOOGLŒA, Cohn. See Bacterium.

ZO'OID.—The more or less completely independent organisms, produced by gemmation or fission, whether these remain attached, or are liberated and set free. (Nicholson, *Zool.*)

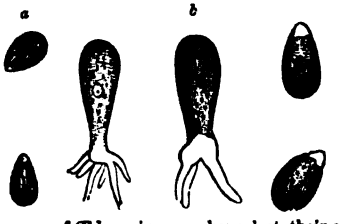
ZO'OPHYTES, or Cœlenterata. See Animal Kingdom, and Polypi; also Hamann, *Organism. Hydroidpolypen*, 1882.

ZO'OSPORES.—The name given to the ciliated active gemmæ or Gonidia produced either singly or, more frequently, after segmentation, in numbers, out of the contents of ordinary or special cells of the Algæ, without any previous process of fertilization. These bodies are generally discharged from

the parent cell in the state of PRIMORDIAL UTRICLES, and acquire a cellulose coat subsequently, when they cease to move, and settle down to germinate and produce a structure resembling the parent. In some cases (in HYDRODICTYON normally, in many other Confervoids abnormally) they become encysted within the parent cell; and it appears most probable that the small cysts with dense and often spinulose coats, such as occur in *Spirogyra* (Pl. 9. figs. 24, 25) and other genera under certain circumstances, are of similar origin. In the VOLVOCINEÆ, zoospore-like bodies form the permanently active individuals of the families.

True zoospores occur pretty generally throughout the Confervoid Algæ, with the exception of Oscillatoriaceæ, Nostochaceæ, and perhaps Diatomaceæ, and are described under the heads of the families or genera. A brief review may be permitted here. The largest form is that produced in the apices of the filaments of VAUCHERIA (fig. 796); it is ciliated all over, and very unlike that of any other genus. In *Œdogonium* (Pl. 9. fig. 7 *c*, & fig. 811) the zoospores are formed out of the whole contents of a cell, and have a crown of cilia around the transparent 'beak.' In other Confervaceæ, as *Cladophora* (Pl. 9. figs. 13 *b*, *c*), *Conferva* (figs. 10 *b*, 11 *c*); in Chætophoraceæ, as in *Chætophora* (fig. 9), *Draparnaldia* (fig. 180, page 271), *Stigeoclonium* (Pl. 9. fig. 5 *c c*); in Ulvaceæ, *Ulva* (Pl. 9. figs. 2 *b*, 3 *c*, *d*), *Enteromorpha* (fig. 4 *b*); in *Protococcus* (Pl. 7. fig. 2 *b*), in ACHLYA, in Desmidiaceæ (Pl. 10. fig. 11), &c., as in all other cases, they are formed either singly from the entire contents, or in small or large number by the segmentation of the entire contents, and mostly break out in various ways, as pyriform bodies with two or four cilia on the transparent beak, moving actively for a time, and then germinating to produce new plants. They appear usually to be surrounded at the moment of discharge by a delicate common sac, composed of cellulose, which expands and quickly disappears, apparently by solution, setting them free; in PEDIASTRUM, however, this envelope appears to be permanent and to hold the gonidia together in the characteristic group or family (Pl. 10. fig. 11). In HYDRODICTYON, as described under that article, their history is different, though the earlier conditions are analogous. It has been found that zoospores of two very different sizes are produced in many Confervoids: these are called *macrogonidia* and *microgonidia* by Braun (see HYDRODICTYON); and a different function is supposed to be exercised by the latter by some authors, who believe they are fertilizing bodies (like SPERMATOZOIDS).

Fig. 811.



Zoospores of Œdogonium. *a* have lost their cilia; and in *b* germination is more or less advanced. Magnified 300 diameters.

Zoospores exist in a large proportion of the Algæ usually included under the FUCOIDEÆ, but which Thuret separates under the name of Phæosporeæ. The Phæosporeæ have sporangia containing motile zoospores, biciliated like the spermatozoids of the Melanosporeæ (or Fucoideæ). This separates them from the latter. The Phæosporous families bear organs called SPORANGES (usually described in Algological works as spores), from which are discharged *zoospores* agreeing in all essential respects with those of the Confervoids, except that the two cilia are often arranged fore and aft, instead of being both in front. Examples of these are described under ECTOCARPUS, MYRIONEMA, CUTLERIA, LAMINARIA, &c. Zoospores have been discovered in Fungi (*Peronospora* and *Cystopus*) by De Bary, and in Lichens by Famitzin; and if *Saprolegniæ* are really aquatic Fungi, their existence is then notorious (Pl. 27. fig. 27). See SAPROLEGNIA.

It remains to direct attention to the distinction between ZOOSPORES and SPERMATOZOIDS, which are sometimes confused together. This confusion is rendered more imminent by the manner in which the *forms* pass one into another. The essential character of a *zoospore* is, that when separated from the parent, it usually becomes encysted and at once developed into a new individual resembling the parent. An exception to this occurs in some of the zoospores of ŒDOGONIUM, which, as the *androspores*, produce special structures in which are developed spermatozoids. And in many cases the zoospores conjugate, before becoming encysted (CONJUGATION).

Spermatozoids are transitory structures; when discharged from the parent cell, they either make their way to a germ-cell of a spore, fertilize it and disappear, or, if debarred from this, at once perish without germination. As stated under SPERMATOZOIDS, these bodies vary much in form. In the higher Cryptogamia they are spiral filaments (Pl. 40. figs. 31–4). In the Fucaceæ they are minute globular bodies with two cilia (fore and aft) closely resembling some zoospores; in the Florideæ they are globules without cilia; and those recently described as existing in VAUCHERIA, among the Confervoids, are also biciliated globules with the cilia fore and aft, while those in SPHÆROPLEÆ resemble the *microgonidia* of this family, having their pair of cilia on the beak; in ŒDOGONIUM they resemble the zoospores, but are smaller. The latter observation is in favour of the microgonidia of *Hydrodictyon*, &c. being spermatozoids.

ZOOTEI'RA, Wright.—A genus of Actinophryina (Rhizopoda).

Char. Body furnished with numerous contractile acuminate rays, elevated on a contractile pedicel; the rays become thickened towards the point when not fully expanded.

BIBL. Wright, *Pritchard's Infusoria*, 563.

ZOOTHAM'NIUM, Ehr.—A genus of Vorticellina (Peritrichous Infusoria).

Char. Body like *Vorticella*, usually of different shapes, attached to the ends of a branched zoary; internal muscle branched and continuous. Many species, salt and fresh water.

Z. arbuscula (Pl. 32. fig. 22). Branches of polypidom racemose-umbellate, bodies white, stalks very thick. Freshwater; length of polypidom 1-4″; of bodies 1-430′.

BIBL. Ehr. *Infus.* 288; Stein, *Inf.*; Clap. & Lach. *Inf.* 101; Kent, *Inf.* 693.

ZOS'IME, Boeck.—A genus of Copepoda. *Z. typica*, in dredgings. (Brady, *Copepoda*, ii. 14.)

ZOS'TERA, L.—A genus of Monocotyledonous Flowering plants (Nat. Ord. Zosteraceæ), growing in sea-water; remarkable for the POLLEN, of which the grains are represented by tubular filaments destitute of an outer coat and exhibiting ROTATION when fresh.

ZYGNE'MA, Agardh, in part (*Tyndaridea*, Bory, Hassall).—A genus of Zygnemaceæ (Confervoid Algæ), consisting of filamentous plants, with the green contents of the cells arranged in twin stellate or lobed masses in each joint (fig. 137, page 204). This stellate appearance arises from the presence of radiating threads, like those from the nucleus of SPIROGYRA; hence it cannot be well observed in dried specimens. Cell-division with previous division of the stellate masses may be well studied in this genus. Kützing separates from this genus all the forms in which the spore is formed in the cross branch produced in conjugation, associating them with *Zygogonium*. We prefer to follow Hassall's distribution of the forms, seeing that *Zygogonium ericetorum* is a plant of very different appearance. If the said character is constant, this genus might be divided into two.

Spores in one of the parent cells.

Z. cruciata (fig. 137, p. 204). Filaments 1-600″ in diameter; joints equal or twice as long; spores globose (Hassall, *l. c. infra*, pl. 38. fig. 1; Kütz. *l. c. infra*, v. pl. 17. fig. 4). *Z. Dillwynii* and *stellina* of Kützing appear to be only smaller states of this, as also *Tynd. lutescens*, Hassall, and *T. anomala*, Ralfs.

Z. stagnalis. Filaments 1-2640″ in diameter, joints three or four times as long; spores globose or oblong (Hassall, *l. c.* pl. 38. figs. 9, 10). *Tynd. ovalis*, Hass., is perhaps a larger form of this.

Z. insignis. Filaments 1-1800 to 1-1560″ in diameter, joints twice as long; spores globose (Hass. *l. c.* pl. 38. figs. 6, 7; Kütz. *l. c.* v. pl. 17. fig. 1).

Z. bicornis. Filaments 1-440 to 1-200″ in diameter, joints twice as long; spores globose (Hass. *l. c.* pl. 38. fig. 5; Kütz. *l. c.* v. pl. 16. fig. 3).

Spores in the cross branches.

Z. immersa. Filaments 1-1200″ in diameter, joints about half as long again; transverse processes very thick, filled by the large and globose spore (Hass. *l. c.* pl. 39. fig. 3; Kütz. *l. c.* v. pl. 12. fig. 5).

Z. conspicua. Filaments 1-1440 to 1-1080″ in diameter, joints equal or twice as long; transverse processes long, ventricose in the middle, where they enclose the ovate-globose spore (Hass, *l. c.* pl. 39. figs. 1, 2; Kütz. *l. c.* v. pl. 12. fig. 2).

Z. decussata. Filaments 1-1440″ in diameter, joints three times (more rarely five times) as long; transverse processes short

and filled by the globose spore (Hass. *l. c.* pl. 39. fig. 6; Kütz. *l. c.* v. pl. 11. fig. 4).

Z. Ralfsii. Filaments 1-1920 to 1-1440″ in diameter, joints three or four times as long; transverse processes very much dilated in the middle, containing an elliptical spore, with the long axis at right angles (Hass. *l. c.* pl. 39. figs. 4, 5; Kütz. *l. c.* v. pl. 11. fig. 2).

Z. pectinata. Filaments 1-660″ in diameter, joints equal or a little shorter; cell-contents transversely bipartite, more frequently radiato-dentate, pectinate, dull green (Kütz. *l. c.* v. pl. 14. fig. 4; *Eng. Bot.* pl. 1611?). Possibly this is only a state of *Z. cruciata* with the spores in the transverse processes; if so, the subdivision above indicated cannot stand.

Bibl. Hassall, *Algæ*, 160, pls. 38, 39 (*Tyndaridea*); Kütz. (*Zygnema* and *Zygogonium*, in part), *Tab. Phyc.* v. pls. 11–17, *Sp. Alg.* pp. 444, 445; Rabenh. *Alg.* iii. 248; Cooke, *Algæ*, 1882.

ZYGNEMA'CEÆ (Pl. 9. figs. 16–28).—A family of Confervoid Algæ, consisting of plants composed of articulated cylindrical filaments, the cells of which often have the green contents arranged in elegant patterns. The principal mode of reproduction, whence the family takes its name, is by Conjugation, followed by a mixture of the entire contents of the united cells, and their conversion into a spore. Other phenomena occur in some instances, such as the production of ciliated zoospores, and small spore-like bodies with a dense spinulose coat (*asteridia*); but these appearances are not yet thoroughly understood (see Spirogyra and Mougeotia).

The British Genera are:—

Spirogyra. Filaments simple, with the green contents arranged in one or more spiral bands upon the cell-wall. Conjugation normally by transverse tubular processes; spores formed in one of the parent cells (or occasionally in both).

Zygnema. Filaments simple, with the green contents arranged in two globular or stellate masses in each cell. Conjugation by transverse processes; spores formed in one of the parent cells, or in the cross branch.

Zygogonium. Filaments simple, or slightly branched, with the contents diffused or arranged in two transverse bands. Conjugation by transverse processes; spores globose, formed in the cross branches, or in blind lateral pouches without conjugation.

Mesocarpus. Filaments simple, with the contents diffused. Conjugation by transverse processes, from which the filaments become recurved; spores in the dilated cross branches.

Staurocarpus. Filaments simple, with the contents diffused (or rarely in moniliform lines). Conjugation by transverse processes, from which the filaments become recurved; spores (or sporanges) square or cruciate, in the dilated cross branches.

Mougeotia. Filaments simple, soon bent at intervals, contents mostly diffused, sometimes in several serpentine lines. Conjugation by the inosculation of the filaments at the convexity of the angles; spores not satisfactorily known.

Thwaitesia, Montagne, resembles *Zygnema* in its stellate cell-contents; but the spore formed in one of the parent cells divides into four portions (perhaps not distinct from *Zygnema*).

Craterospermum, nearly resembling *Staurocarpus* and *Mougeotia*, but with the spore and the short tube in which it is contained subconstricted in the middle.

Pleurocarpus. Simple filaments, with diffused contents, the conjugation taking place between adjacent cells of the same filaments, by means of a short arcuate tube; spore globose, in the tube.

Rhynchonema, Kützing, has spiral cell-contents like *Spirogyra*, but conjugates like *Pleurocarpus*, by an arched tube connecting adjacent cells of the same filament.

Bibl. Kützing, *Spec. Alg.*, *Tabul. Phyc.*; Braun, *Alg. Unicell.* 60; Rabenh. *Alg.* iii. 110; Cooke, *Algæ*, 1882.

See also the genera.

ZYGOC'EROS, Ehr.—A genus of Diatomaceæ. Detached frustules of Biddulphia?

Bibl. Ehrenberg, *Abh. Berl. Ak.* 1839, 131; Kützing, *Bacill.* 138, and *Sp. Alg.* 139; Rabenh. *Alg.* i. 310.

ZYGODAC'TYLA, Brandt.—A genus of Campanulinidæ (Hydroid Zoophytes).

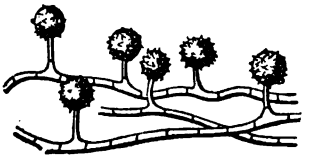
Char. Capsules with an operculum formed by many convergent and acuminate segments; polypes cylindrical, tentacles webbed below; reproduction by free medusiform gemmæ.

Z. vibrina, Ilfracombe. (Hincks, *Brit. Zooph.* 191.)

ZYGODES'MUS, Corda.—A genus of Sepedoniei (Hyphomycetous Fungi). *Z. fuscus* occurs upon bark of fallen branches. Berkeley thinks it possibly may be a form

of some Thelephoroid Fungus. Currey has shown that Corda's figure (fig. 812) is not completely accurate, since he finds the

Fig. 812.



Zygodesmus fuscus.
Magnified 400 diameters.

points at the apex of the fertile pedicels each crowned by a spore; and the normal number of sterigmata is probably four, so that the structure would resemble a basidium of Hymenomycetes. The above figure is after Corda.

BIBL. Berk. *Crypt. Bot.* 298; Currey, *Micr. Jn.* v. 126.

ZYG'ODON, Hook. and Taylor.—A genus of Orthotrichaceous Mosses, deriving its name from the yoking of the teeth in pairs; the species are mostly found in mountainous districts and rarely in fruit.

ZYGOGO'NIUM, Kütz.—A genus of Zygnemaceæ (Confervoid Algæ), consisting of filamentous plants, growing on damp ground or in water, green or yellowish when fresh, purple or brownish when dry. Kützing includes here all Hassall's species of *Tyndaridea* (ZYGNEMA) which produce the spore in the cross branch.

Z. ericetorum, Kütz. Filaments 1-2160 to 1-1440″ in diameter, joints as long or half as long again, cylindrical or torulose (filaments sometimes slightly branched). Conjugation rare, apparently mostly 'chain-like,' from one cell to the next in the same filament. Contents green when growing in water, purple when growing on wet heaths (Hass. pl. 41; Greville, *Sc. Crypt. Fl.* pl. 261. fig. 1). *Conferva ericetorum*, Dillw.

See ZYGNEMA.

BIBL. Hassall, *l. c.*; Greville, *l. c.*; Kützing, *Sp. Alg.* 445, *Tab. Phyc.* v. pl. 10; *Eng. Bot.* pl. 1553; Rabenh. *Alg.* iii. 251.

ZYGOMYCETES.—A group of Fungi, in which conjugation takes place, corresponding to the Conjugatæ of the Algæ, as in the Mucorini &c. (Brefeld, *Schimmelpilze*, 1872; V. Tieghem, *An. Sc. N.* 5. xvii.; Sachs, *Bot.* 268.)

ZYGOSEL'MIS, Duj.—A genus of Infusoria, of the family Euglenia.

Char. Form variable; movement effected by two flagelliform filaments, incessantly in action.

Z. nebulosa (Pl. 32. fig. 23). Body colourless, sometimes globular, at others variously expanded so as to become pyriform or top-shaped, turbid from the presence of numerous granules. Freshwater; length 1-1100″.

BIBL. Dujardin, *Inf.* 369; Kent, *Inf.* 417.

ZY'GOSPORE or AUXOSPORE.—The result of the union of conjugating Algæ.

ZY'MOMES = MICROZYMES.

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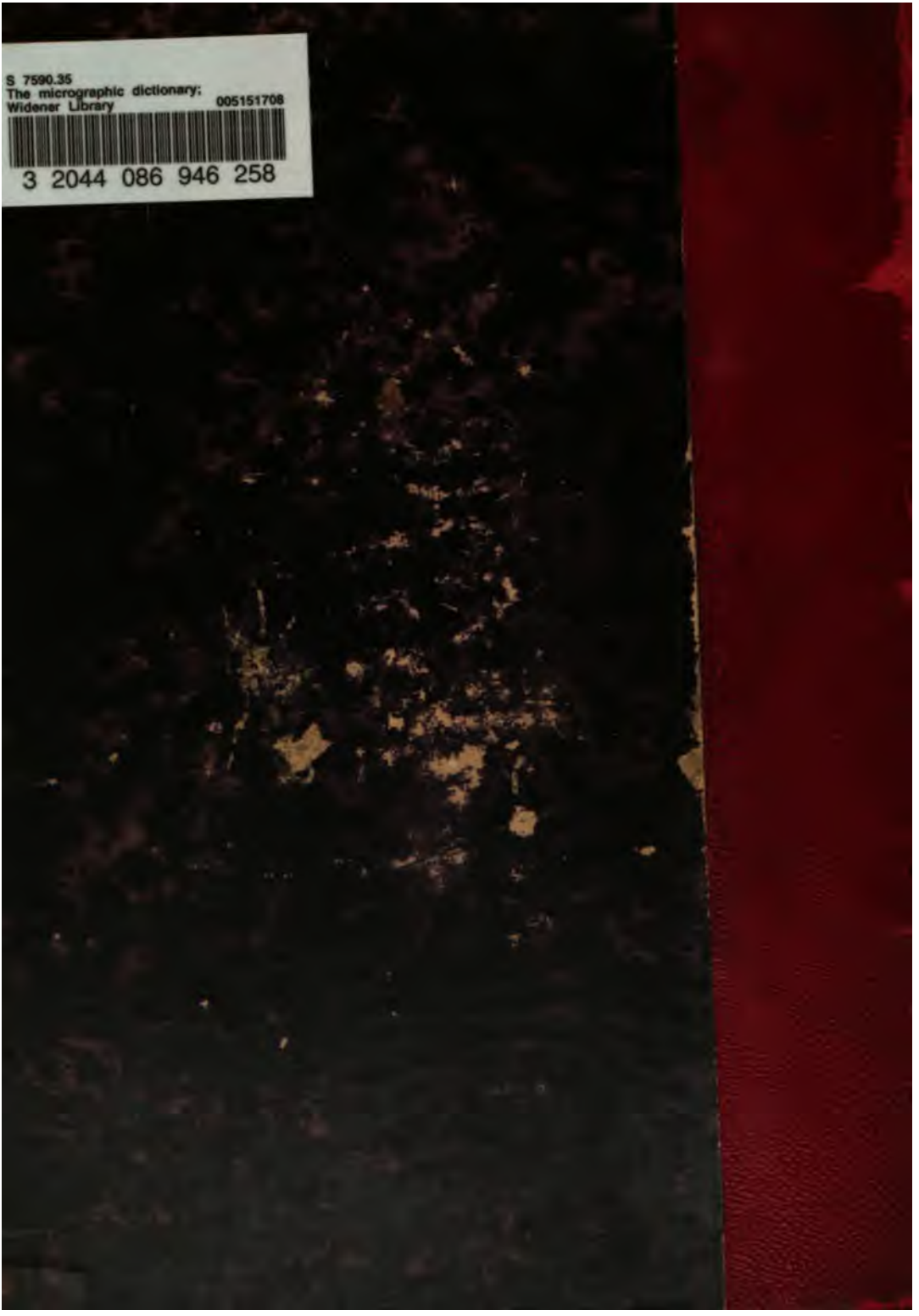
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